

Experimental and Research Station,
Nursery & Market Garden Industries'
- - Development Society, Limited. - -

Turner's Hill, Cheshunt, Herts.

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* C. H. SHOULTS, Esq.

Hon. Treasurer :

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* W. DYKE, Esq.

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SCIENTIFIC STAFF.

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W. F. BEWLEY, C.B.E., D.Sc. (Dunelm).

Entomology :

E. R. SPEYER, M.A. (Oxon), F.R.E.S.

Chemistry :

O. OWEN, Ph.D., M.Sc. (Wales), A.I.C.

Fungicides and Insecticides :

W. READ, M.Sc. (B'ham), A.I.C.

Mycology :

P. H. WILLIAMS, B.Sc. (London).

Virus Disease Investigations :

G. C. AINSWORTH, Ph.D., B.Sc. (London).

Diseases of Vegetables :

H. L. WHITE, Ph.D., M.A., D.I.C., Dip. Hort. Sci.

Diseases of Flowers :

ENID OYLER, B.Sc. (London).

Physiology :

*B. D. BOLAS, D.Sc. (London), D.I.C.

*D. W. GOODALL, B.Sc., A.R.C.Sc. (London).
(Beit Scientific Research Fellow.)

* Members of the Staff of the Imperial College of Science working at Cheshunt.

Extension Officer : O. B. ORCHARD.

Director's Assistant : J. E. MORTON.

Secretary : HELEN MARCHANT.

Assistants : JOYCE M. MASSON and JOYCE FULLER.

Glasshouse Working Staff :

Foreman : A. A. RICHARDS.

Assistants : T. ANDEREGG, F. BLAKE, F. W. BUTLER, A. E. JUDD, T. PRICE, J. H. SMITH, T. W. SYER, T. K. TRUCKLE, L. WILKINSON.

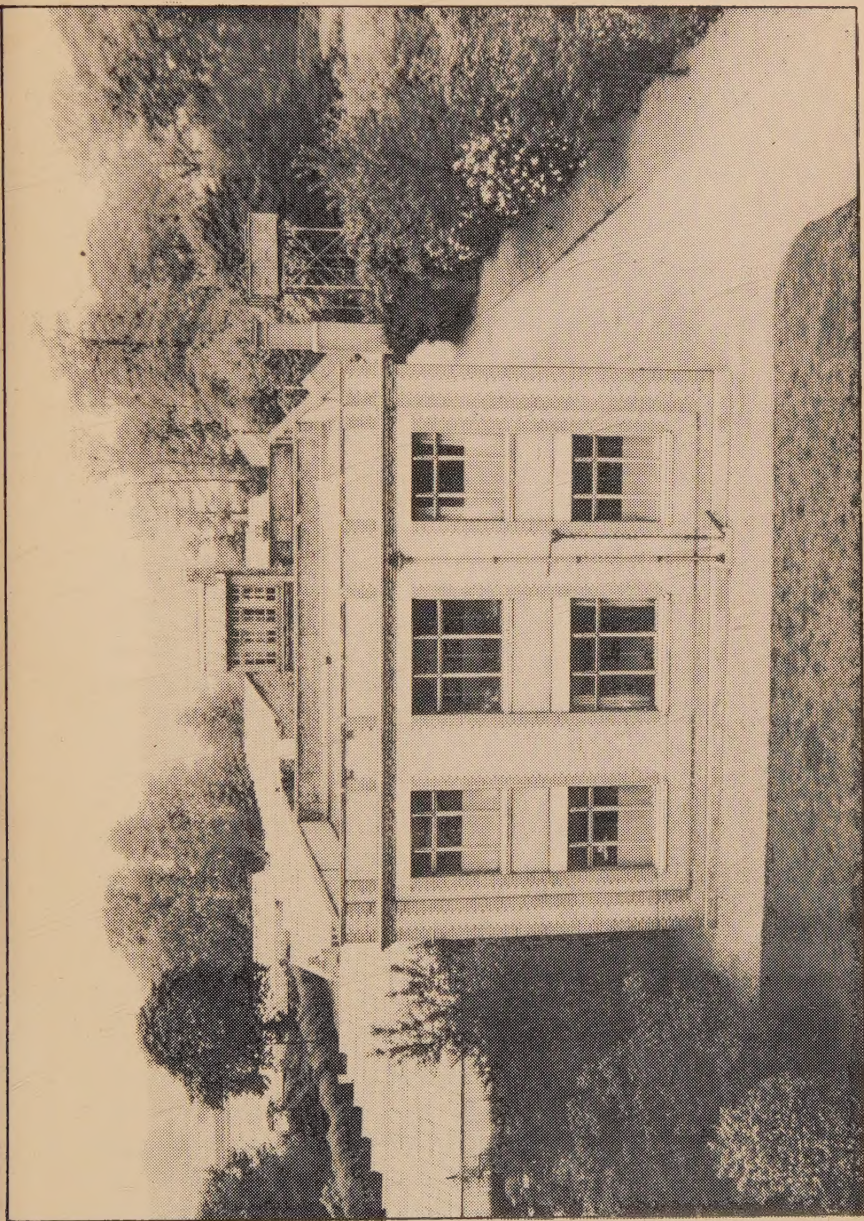


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Introduction.

ONE of the outstanding features of 1937 was an attempt to raise funds sufficient to start a centre where virus free cucumbers, lettuce and tomatoes can be grown for the production of virus-free seeds.

Virus diseases are causing much concern to growers of many different crops all over the world, and a great deal of research is being carried out in connection with these diseases. Glasshouse growers in this country know only too well their injurious effect upon tomato crops, and to a lesser extent on cucumbers and lettuce, by reducing quality and productiveness.

So far as is known at present there is only one practical way of overcoming virus diseases in glasshouses, namely, by using seeds taken from virus-free plants growing in an isolated locality. Trial has shewn that when virus-free seeds only are used, infection from outside sources can be prevented by exercising a little care, and at the worst it is not likely to be introduced until the crop is almost finished.

Small supplies of virus-free seeds of tomatoes and cucumbers are available at the Research Station, but as the Society is not a trading body it is proposed to establish a Seed Growers' Association, at the Research Station, for the purpose of carrying on the business of producing virus-free seeds of improved varieties and strains of glasshouse plants for distribution to its members.

The Seed Growers' Association would be a separate organisation, registered under the Friendly Societies' Act, and be responsible, financially and otherwise, for carrying on the business of the Association.

The Association would possess a capital of £6,000, made up of six thousand shares each of the value of £1.

Growers could join the Association by taking a *minimum* number of shares in accordance with the following scale:—

Nursery less than $\frac{1}{2}$ acre of glasshouses	-	One £1 share.
Nursery between $\frac{1}{2}$ acre and 1 acre	-	Two £1 shares.
Nursery, 1 acre	- - -	Two £1 shares.
Nursery, 2 acres	- - -	Four £1 shares.
Nursery, 3 acres	- - -	Six £1 shares.
Nursery, 4 acres	- - -	Eight £1 shares.
Nursery, 5 acres	- - -	Ten £1 shares.

Growers with more than five acres of glass could join the Association by taking a minimum of ten £1 shares. It is suggested that the maximum number of shares held by any one person should not exceed two hundred and fifty.

The management of the affairs of the Association would be carried out by an Executive Committee. In the first year the Executive Committee would be elected by the Council of the Experimental Station, but afterwards this body would elect two-thirds of the Committee only the remaining one-third being elected at the Annual Meeting of Shareholders.

The Executive Committee would be responsible for the purchase of land, erection of glasshouses, and for the growing of any such crops as may be necessary to raise seeds or plants for distribution; they would also undertake the raising of new and improved market varieties. The Executive Committee would also be responsible for fixing the price of plants or seeds distributed, and for the conduct of the general business of the Association.

The Shareholders of the Association would have the right to share in the supply of seeds available in accordance with their requirements as growers, except as might otherwise be determined by the Executive Committee. If after the Shareholders' requirements have been satisfied there is still a surplus the Executive Committee might distribute this, though at prices and in such a manner as they would consider to be in the interest of the Association.

It should be noted, therefore, that it is by becoming Shareholders and Members of the Association that growers can be assured of a supply of seed practically free of virus disease, and it is, therefore, in their own interest to join the Association.

The most popular varieties would be grown, and in the opinion of the Members of the Council of the Experimental Station, nine separate houses for tomatoes, six for cucumbers, one for lettuce and one thousand Dutch lights would be needed for growing the three crops. In order to ensure that the plants are kept free of virus disease the houses would be erected in a district isolated from other glasshouses.

At present some £3,000 only have been subscribed or promised, so the Committee has decided to proceed with the venture, but on a smaller scale than was first designed.

It is important that growers should join in this scheme and so help forward the production of virus-free seeds, and at the same time safe-guard their own supplies.

Members' Day.

Members' Day was held on Tuesday, 1st June. The visitors assembled at the Research Station at 10.30 a.m., and were conducted through the laboratories and experimental houses. Lunch was served at 1 p.m., and after a short lecture by the Director on "Current Investigations," the laboratories, etc. were thrown open and the visitors were invited to wander around at will. Members of the staff were available to answer questions and explain the work.

Tea was provided in the Halsey Memorial Hall, by the courtesy of the president, Mr. C. H. Shoults.

Membership.

Membership of the Society, under whose auspices the experiments are conducted, is open to all growers and interested persons. Subscriptions are payable at the rate of two guineas for each acre of glass cultivated by the

subscriber ; in return, members receive all publications and any advice which is available. Members continue to be enrolled but many more are needed both to provide additional funds for research and to obtain complete co-operation in controlling the various pests and diseases common to glass-house plants. Serious outbreaks over a wide area must be fought by all growers ; isolated attempts to control disease are almost bound to fail.

Endowment Fund.

An endowment fund has been opened to receive contributions from those who desire to further the work of the Station. The capital is invested in Trustees and the interest only will be used for (a) future development, and (b) repayment of debt.

It is hoped that those who can possibly contribute to this fund will do so, and so help to secure the Station's future prosperity.

Current Investigations.

The investigations with tomatoes have been concerned with quality of the produce as affected by root restriction, manurial treatment, distance of planting, etc.

The experiments with pots and cardboard containers have been continued. Each block of experiments contained four treatments. In two, the plants were grown in ten inch clay pots, using steam sterilized soil in one and virgin soil in the other. Control plants were grown in the ground and in the fourth treatment cardboard containers were used. The earliest crop came from the pots, although the plants in cardboard containers were not far behind, and produced the heaviest crop of all.

The fruit from the pots was definitely firmer and slightly earlier than in the controls. That from the cardboard boxes was slightly inferior and later than from the pots, but it was superior to and earlier than from plants grown in the ground. The experiment will be repeated in 1938.

In another experiment, occupying one and a half houses, the effect of the distance between the plants upon crop yield and quality was investigated.

Normally the plants are set out in double rows, 18 inches apart, the plants being 14 inches apart in the rows. The double rows are separated by paths 27 inches wide. This method was tested against three others. In one, the rows were normal, but the plants were 18 inches apart instead of 14. In two other methods single rows were planted 27 inches apart, the plants being 14 inches and 18 inches apart respectively.

The crop yield from the first three methods was approximately the same, but it fell off rapidly in the last method, where the plants were 18 inches apart in single rows 27 inches apart. A larger percentage of seedless "chats" resulted thus shewing that the "setting" was not so good. The quality of the fruit did not vary in the different plots.

In view of the ease with which the single rows can be managed during cultivation and spraying, growers may wish to test for themselves the method of planting single rows 27 inches apart, with the plants 14 inches apart in the rows.

Advantage was taken of the presence of eelworm in houses 8 and 9 to test the effect of treating the soil with cresylic acid, a proprietary soil sterilizer and potassium iodide. The soil in these houses was also warmed as in previous years. While crops varying from 43 to 47 tons per acre were obtained, root infection by *Heterodera marioni* was abundant by the end of the season, thus shewing that the treatments had not succeeded in eliminating the eelworms from the soil. In the presence of eelworms, soil warming did not produce its usual increase in crop.

The trials in the variety house also proved unsatisfactory during the past year owing to a new infection of the eelworm, *Heterodera marioni*. The heaviest yields, however, were produced by a cross between Blaby and Potentate, Helvetia and E.S.1, and an American variety,

Planter's Favourite. The first and third of these, however, produced very coarse fruit unsuitable for the English market. The cross between Helvetia and E.S.1 shews some promise.

Among the varieties resistant to leaf mould grown in houses 1 and 2, the strains Stirling Castle $\times$ E.S.1 $\times$ Radio, and Stirling Castle $\times$ E.S.1 $\times$ Potentate retained their resistance and yielded a satisfactory crop.

A new cross between Potentate and Kondine Red was also tested in the F.3 generation. Although a mixed strain it shewed great promise both for weight of crop and firmness of fruit. Three particularly good plants yielded $14\frac{1}{2}$, 15, and $16\frac{1}{2}$ lbs. of fruit respectively.

The process of applying a layer of moist peat over the surface of the soil as soon as the bottom truss has been cleared continues to prove of considerable value in assisting plants whose root action is weakened by disease or by unsuitable soil conditions. It is being adopted extensively in commercial houses.

The cucumber investigations were a final experiment on the value of electric light during the propagation stages of an early crop. Seeds were sown on 5th November and the irradiated plants transferred to permanent quarters on 1st January, 1937. As in previous experiments excellent plants were grown with the aid of additional light. Picking usually begins 15 days before the controls, but this year it started only three days sooner. The process cannot be recommended to commercial growers as a practical proposition.

Two excellent crops of Cheshunt Early Giant lettuce were grown for Christmas and the end of February respectively. The variety has fulfilled its early promise and is now established as the best glasshouse lettuce for marketing between November and March.

Cheshunt Early Ball lettuce has now passed its trials as a type for cold frames and hot beds. It has proved to be a satisfactory variety of good quality with a tender and firm heart, and is well worth consideration by commercial growers.

The investigation of crops in frames was devoted to the study of soil warming. The land is divided into four sections in which the soil can be maintained at temperatures of 55°F., 60°F., and 65°F. respectively, one section being left unheated as a control. The heating apparatus takes the form of a single loop of 1 inch piping buried 20 inches below the surface under each line of frames. Hot water is circulated through the pipes by means of an electric pump, the temperature being regulated by thermostat.

The effect of soil warming was tested on a number of different crops including the narcissus, tulip, violet, anemone, lettuce and carrot. The results of these preliminary trials were distinctly promising, especially in the case of lettuce, which at soil temperature of 60°F. was cut four weeks before the control plants in unheated soil.

The mushroom experiments were designed to test the effect of different types of casing soils imported from certain nurseries in the Lea Valley. All were sterilized by steam before use, thus preventing the introduction of diseases and pests in the casing soil. The crop was most successful, being an average of 3½-lbs. per square foot. Crop weight and form of mushroom varied in relation to the sample of soil used for casing. Preliminary experiments with peat and stones, indicated that heavier crops can be obtained by adding a proportion of either peat or small stones to the casing soil.

In the entomological investigations much attention has been given to the Rose Thrips (*Thrips fuscipennis* Hals.) Adult females have been found overwintering in crevices in the bark of old rose bushes under glass; also in the bark of various trees out-of-doors, notably beech. They have not been found in soil or in moss or debris beneath plants infested during the previous summer. The Rose Thrips lays the majority of its eggs in the sepals or stalk immediately adjoining them.

The damage caused on commercial nurseries was more severe than in previous years, and control measures which once appeared promising failed to prevent an almost

complete loss of crop. Much additional work has been done in an attempt to devise an effective control, but so far no satisfactory treatment has been found.

Further investigations into the egg-laying habits of the Onion Thrips (*T. tabaci* Lind.) show that this insect lays its eggs in the young leaves or in the bases of the petals of cyclamen after the flowers have opened to some extent, eggs did not occur upon the outside of the petals, upon the sepals, or flower-stalks.

The apparant immunity from attack exhibited by pink varieties of carnation is probably due to a dislike which the larvae (and adults) of Onion Thrips have of feeding upon their petals. As many eggs were found upon the outside of the sepals of pink as of dark varieties susceptible to attack in the case of unopened flower-buds.

Through the generosity of Prof. H. S. Smith, of California University, a consignment of living *Scolothrips* was received from California in October. This insect is predatory upon Red Spider Mite but it appears doubtful if it will survive the winter upon the carnation plants to which it was given access upon arrival.

Investigations concerning the control of pests on mushroom beds have been continued. A number of insecticides have been tested, and satisfactory control of the mite, *Tyroglyphus longior* has been obtained by the use of naphthalene.

Many proprietary insecticides and fungicides, including soil sterilizing agents, have been submitted for examination and have been tried against various glasshouse pests.

Methods of controlling the scale insects *Hemichionaspis aspidistrae* and *Saissetia coffeae* causing damage to ferns have been examined; dipping the plants in a petroleum oil emulsion has proved satisfactory.

The mycological investigation of cucumber root rot has been continued. A large number of organisms have been isolated but attention is being concentrated on the different species of *Fusarium* which are commonly associated with this disease.

Experiments have shewn that cucumber roots become brown and die when they penetrate into excessively wet, sterile soil. Further a high degree of saturation is detrimental when the temperature and light intensities are low.

The investigation of a wilt disease of chrysanthemums caused by *Verticillium sp.* has begun. This disease has spread steadily during the past ten years and is transmitted largely by cuttings taken from infected plants.

A leaf spot of marguerite caused by *Ramularia bellunenis* was recorded for the first time in this country.

Inoculation experiments with a *Phytophthora* isolated from wilted plants of *Erica sp.* have shewn this fungus to have a wider host range than *P. Cinnamomi*, the common cause of wilt in these plants.

Lettuce Mosaic was the subject of further investigation and the important fact has been established that the virus is seed transmitted to the extent of approximately 5 per cent.

Several interesting new records for yellow-mottle mosaic of cucumber virus have been obtained during the year.

Further experiments were carried out to examine certain factors which determine the incidence of "Water Spot" of tomato fruits caused by the grey mould fungus, *Botrytis cinerea*.

Tulip and narcissus bulbs were grown in sand with the addition of varying concentrations of phosphate, nitrogen and potash. No difference was noted in the growth of treated and control bulbs in the first season.

Work on translocation in tomato seedlings has been continued and a large number of experiments have been carried out under various environmental conditions, but the data have not yet been fully examined.

Changes in carbon content and ash of the various parts of the plant during the 24 hour period are being investigated with a view to a fuller understanding of the metabolic process taking place in the seedling.

The effect of light intensity, seed age and various artificial treatments of the seed on the position of the first flower truss have been studied.

Another serious case of damage from chlorate weed-killer is reported by a chrysanthemum grower who suffered heavy losses after applying chlorate to the "standing-out" ground in the spring of 1936. Further losses were experienced in the 1937 crop despite the fact that no weed-killer was used after the first application. Chlorate had been taken up by the pots and, as already stated in previous reports, it is not easy to wash out this poison from such pots.

Further work on the disappearance of nitrates from tomato soil has revealed an evolution of ammonia from the surface of the soil in some of the experimental plots.

Analyses have been made of lettuce plants to determine the effect of manurial treatment on the composition of Cheshunt Early Giant grown during the winter.

Obituary.

It is with profound regret that we record the deaths of three members of the Committee during the past year.

On 13th July Professor H. E. Armstrong, Ph.D., L.L.D., F.R.S., who had been a member of the Committee since 1913, passed away at the age of 89 years, after an illness which lasted some months. Professor Armstrong was a chemist of great renown and his researches in connection with naphthalene, camphor, and the behaviour of enzymes established a reputation which was world wide. He was especially successful as a teacher, and his pupils have gained high honours in academic and industrial careers. He will be remembered as a man of profound knowledge and fearless criticism, who from time to time sponsored various reforms with great vigour and skill in connection with pure milk, natural foods, and honest beer. He was fond of the open country, and of his garden, where the colours of flowers intrigued and delighted him. His work on the Committee was valued greatly and his death came as a severe shock, for despite his age he seemed to have solved the problem of perpetual youth.

Thirteen days later came the death of Mr. E. F. Meering, who six months previously had been elected to serve on the Committee by the Lea Valley Growers' Association. Mr. Meering was still a young man when he died, but he had already proved his worth as a grower and will be greatly missed by his many friends.

On 6th November Dr. J. A. Voelcker passed to his rest in his 84th year, after a short illness. Dr. Voelcker was well known in the agricultural world as a chemist with a wide practical experience. For over fifty years he was consulting chemist to the Royal Agricultural Society and was in continual contact with the leaders of agricultural science and practice. He was honorary Director of the Woburn Experimental Station, an institution to which he was much devoted. In 1889, at the request of the Indian Government, he was sent

out to India by the Secretary of State to advise upon possible improvements in Indian agriculture. His report had a far-reaching effect upon the development of agriculture and agricultural education in that country, but it was not until 1928 that he was honoured by the conferment of the distinction C.I.E. He held many appointments as consulting chemist and agricultural analyst and was in constant demand as an expert witness in legal matters. In his youth he was a well-known athlete and established a reputation as a long-distance runner. He was an active member of the congregation of St. John's Presbyterian Church in Kensington, which he attended regularly during the past 67 years, and did much outside work in connection with church extension.

Dr. Voelcker had served on the Station Committee since 1913 and was a most regular attender. His knowledge and wide experience was ever at the disposal of the staff, and he spared no pains to help those in difficulty. His genial presence and handsome figure graced many a gathering of growers. He was essentially an old English gentleman, beloved by all, and as such will be greatly missed by those who came in contact with him.

DIRECTOR'S REPORT.

1. Experimental Results of 1937.

1. Tomatoes.

The propagating season for the 1937 crop was unfavourable in most parts of the country. Warm dull weather prevailed, which encouraged leaf growth out of proportion to that of the roots. Diseased roots were common and in some districts many thousands of plants had to be destroyed for this reason. Frequently the diseased state was not noticed at planting time and since it was due to weak pathogens, which make slow progress, the plants did not shew severe symptoms until some weeks after planting. Where this occurred the past season's crop proved far from satisfactory. In more favoured districts, where good light prevailed, the 1937 crop was very good and heavy yields have been obtained. The season's work emphasises the need for good light during the winter months.

The practice of grading the tomato fruits from the experimental plots, adopted in 1921, was continued.

- A.—“Pinks” number 5 to 7 and “Pink and White” 8 to 10 to the lb. These are the best quality of fruit in size, shape, and colour; “Pinks” being slightly larger than “Pink and Whites.”
- B.—“Whites.” These fruits are of good colour but smaller than “Pink and White.”
- C.—“Blues.” This grade consists of fruits of good colour but larger and more irregular in shape than Grade A.
- D.—“Roughs.” Small mis-shapen fruits about the size of cherries.
- E.—Blotchy fruits which ripen irregularly.
- F.—Fruits shewing Blossom End Rot.
- G.—Fruits shewing the lesions of Stripe Disease.
- H.—Fruits shewing “Green Back.”

(a) Houses 1 and 2. Root restriction experiment.

This investigation, begun in 1936, was continued in 1937. Four series were arranged. In two of them the plants were grown in 10-inch pots, one series being filled with sterilized and one with unsterilized soil. In another series the plants were planted in cardboard boxes, 8 inches by 8 inches by 10 inches, and in the last series they were planted on the ground. The experiments were arranged in three groups each containing four treatments.

The arrangement is illustrated in Fig. 1 and the results given in Table 1. The standard error per plot is approximately 4.6% of the mean yield, and the crop from the cardboard containers is significantly higher than that from any other treatment. Unfortunately the soil used for the pots, which had been imported from the west of the county, proved unsatisfactory and root development was checked severely both in steamed and unsteamed soil. In consequence, the yields from the pots is much lower than would have been the case if good soil had been used. In spite of this, however, the fruit from the pots was definitely firmer and slightly earlier than from the cardboard boxes.

The quality of the fruit from the cardboard containers was good but slightly inferior to that from the pots. It was, however, superior to that from the plants growing in the ground, and was picked earlier.

The experiments will be continued in 1938, but in view of the past two years' results it seems that the use of cardboard containers of suitable type is worth consideration by growers.

(b) Houses 3 and 4. Distance of planting.

The experiment commenced in 1936 was repeated.

Two blocks of four plots were laid down in House 3 and one block in the South half of House 4. Each block contained four plots in which different planting distances were employed. In the control plot of each block of four, plants were set out in double rows 18 inches apart, with a path 27 inches wide between the double rows: the plants were 14 inches apart. The second plot was similar except for the fact that the plants were spaced 18 inches apart in the rows. In the third plot single rows 27 inches apart were used, the plants being 14 inches apart in the row. In the last plot the method was similar to the third plot, but the plants were 18 inches apart in the row. The arrangement of plots is shewn in Fig. 2 and the results in Table 2.

Figure 1.
Root Restriction Experiment.

4 B	13 C	4 A	13 D
3 C	14 D	3 B	14 A
2 A	15 B	2 D	15 C
1 D	16 A	1 C	16 B

House 1.

House 2.

A=Unsteamed Soil in 10-inch Pots.

B=Steamed Soil in 10-inch Pots.

C=Unsteamed Soil in Cardboard Containers.

D=Planted in the Ground.

Table 1.

House	Plot	Treatment	CROP YIELD IN LBS. PER PLANT						Total tons Per Acre	Average tons Per Acre
			May	June	July	Aug.	Sept.	Oct.		
1	2	Planted in 10" clay pots: unsterilized	0.04	1.71	2.40	1.21	0.44	0.30	6.10	44.30
2	4	virgin soil...	0.11	2.16	1.67	0.56	0.43	0.45	5.38	
1	16	" " " "	0.05	1.65	1.59	1.01	0.46	0.25	5.01	
2	14	" " " "	0.21	1.90	1.80	0.69	0.32	0.49	5.41	
1	4	Planted as above but soil sterilized by	0.05	1.55	2.43	1.20	0.56	0.39	6.18	43.31
2	3	steaming ...	0.20	1.58	1.04	0.63	0.47	0.44	4.36	
1	15	" " " "	0.03	1.50	2.12	1.30	0.50	0.49	5.94	
2	16	" " " "	0.27	1.42	1.37	0.65	0.27	0.68	4.66	
1	1	Planted in cardboard boxes, 8" x 8" x 10"	0.07	1.57	2.06	1.34	0.50	1.07	6.61	52.37
2	2	soil not sterilized...	0.06	1.98	2.09	0.75	0.58	0.70	6.16	
1	14	" " " "	0.01	1.43	2.52	1.39	0.65	0.78	6.78	
2	13	" " " "	0.18	1.98	1.98	1.11	0.41	0.65	6.31	
1	3	Planted in the ground: soil not sterilized	0.03	1.37	2.77	1.37	0.71	0.67	6.92	45.34
2	1	" " " "	0.21	1.22	1.51	0.65	0.53	0.62	4.74	
1	13	" " " "	0.01	1.18	2.53	1.40	0.62	0.69	6.43	
2	15	" " " "	0.17	1.17	1.44	0.65	0.35	0.52	4.30	

Figure 2.
Planting Experiment.

House 3.

House 4.

4 B	5 C	6 B	7 A
3 D	6 A	5 D	8 C
2 B	7 C		
1 A	8 D		

A = Rows 18-in. and 27-in.; plants 14-in. apart in rows.

B = „ 18-in. „ 27-in. „ 18-in. „ „ „

C = „ 27-in. apart; plants 14-in. apart in rows.

D = „ 27-in. „ „ 18-in. „ „ „

Table 2.

House	Plot	Planting Distance	CROP YIELD IN TONS PER ACRE							Average Tons Per Acre
			May	June	July	Aug.	Sept.	Oct.	Total	
3	1	Rows 18" and 27" apart : plants 13" apart in row	0.51	6.56	16.01	7.02	2.83	3.22	36.15	} 36.66
3	6	" " " " " " " "	—	6.94	19.06	9.04	3.23	2.84	41.11	
4	7	" " " " " " " "	—	5.71	13.77	7.87	2.14	3.22	32.71	
3	2	Rows 18" and 27" apart : plants 18" apart in rows	0.39	7.35	16.06	9.21	2.96	3.59	39.56	} 38.69
3	4	" " " " " " " "	—	4.60	16.87	8.95	3.78	3.36	37.56	
4	6	" " " " " " " "	—	5.81	16.07	7.78	5.15	4.13	38.94	
3	5	Rows 27" apart : plants 13" apart in row	—	5.66	16.78	8.56	3.07	2.94	37.01	} 36.62
3	7	" " " " " " " "	0.16	7.43	16.91	7.12	2.94	2.53	37.09	
4	8	" " " " " " " "	—	5.32	15.30	6.62	3.45	5.06	35.75	
3	3	Rows 27" apart : plants 18" apart in row	0.15	5.31	14.79	6.31	2.70	3.07	32.33	} 32.57
3	8	" " " " " " " "	0.12	5.41	13.73	5.69	2.77	2.62	30.34	
4	5	" " " " " " " "	—	4.71	15.84	6.79	4.06	3.65	35.05	

Statistical examination of the results given in Tables 2 and 3 shews that the widest spacing gives too few plants to the acre for Lea Valley conditions, for the yield is significantly low. The other methods of planting gave approximately the same yields per acre, although they suggest that the standard method of planting in rows 18 inches apart, with paths 27 inches between double rows, and allowing 14 inches between plants in the rows, results possibly in over-crowding.

The quality of the fruit did not vary in the different plots, but "setting" was not so good in the widest spacing as in the others, probably due to the atmosphere being drier in the neighbourhood of the flowers.

(c) Houses 7 to 10. Soil sterilization and soil warming.

In these experiments advantage was taken of the presence of the tomato root eelworm, *Heterodera marioni*, in the soil of Houses 7, 8, and 9 to test the comparative effects of treating it with potassium iodide (two rates of application), cresylic acid, and a proprietary soil sterilizer.

The treatments were arranged in Houses 8 and 9, making four blocks of plots each containing the four treatments. In House 10, where the eelworms were absent, the East side was left as an untreated control, and the West side was treated with the proprietary sterilizer. This side was divided into two equal sections, in one of which the sterilizer was mixed with the top 20 inches of soil and in the other with the top 10 inches only. House 7, which had been sterilized by steam for 1936, was left untreated in 1937. The soil in Houses 8 and 9 was warmed for the first twelve weeks as in previous years.

The highest yield 49.6 tons per acre was provided by House 7, which had been steamed for 1936. On the East side of this house the yield averaged 54.7 tons per acre, and on the West side, slightly reinfected with eelworms from the adjoining House 8, it averaged 45 tons per acre.

Owing to eelworm attack, which was not prevented by the compounds applied, the soil warming in Houses 8 and 9 did not produce its usual crop improvement.

In Table 4 are given the results of these experiments, and it will be seen that there was little difference in yield per acre between any of the treatments in Houses 7 and 8. Inspection of the roots at the end of the season shewed fairly heavy infection by eelworms, and there was little difference between the appearance of the roots in the different plots.

Table 3.

House	Plot	Planting Distance	GRADE OF FRUIT: PERCENTAGE OF TOTAL							
			A	B	C	D	E	F	G	H
3	1	Rows 18" and 27" apart: plants 14" apart in the rows	72.02	7.58	9.67	2.90	5.59	—	1.85	0.39
3	6	" " " " " "	68.90	9.61	12.38	2.89	4.91	—	1.02	0.29
4	7	" " " " " "	75.92	10.84	2.29	2.87	4.07	—	1.16	2.85
3	2	Rows 18" and 27" apart: plants 18" apart in the rows	70.92	8.12	12.76	2.16	4.30	0.05	1.16	0.53
3	4	" " " " " "	71.05	6.24	13.04	1.97	4.90	—	2.56	0.24
4	6	" " " " " "	77.53	5.75	4.33	2.07	8.86	—	0.02	1.44
3	5	Rows 27" apart: plants 14" apart in the rows	73.25	8.81	8.92	3.16	4.78	—	0.97	0.10
3	7	" " " " " "	70.49	8.23	12.50	2.72	4.88	—	1.02	0.16
4	8	" " " " " "	76.28	7.55	2.23	1.68	8.14	—	0.90	3.22
3	3	Rows 27" apart: plants 18" apart in the rows	68.63	6.63	17.35	2.10	4.52	—	0.62	0.15
3	8	" " " " " "	66.42	6.59	16.72	3.46	4.78	0.19	1.58	0.26
4	5	" " " " " "	73.47	5.25	5.31	1.57	10.04	—	2.68	1.68

In House 10 the yield was increased by the sterilizing agents employed, the control plots yielding 45.5 tons per acre and the sterilized plots an average of 53.3 tons per acre. There was, however, only a slight crop increase as the result of sterilizing the soil to a depth of 20 inches as compared with sterilization of only the top 10 inches. These results suggest that while the sterilizing agent used in House 10 increases the fertility of the soil, and induces clean root growth for the first half of the season, it does not prevent reinfection by eelworms towards the end of the season.

It will be remembered that during the season of 1936 plots 5 and 7 in House 10 were infected with *Verticillium albo-atrum* by adding old tomato haulms fermented by the A.D.C.O. process, and that the yields amounted to only 13.49 tons per acre, the plants being dead by the end of July. This infecting agent was destroyed by the application of the sterilizing fluid used for 1937 and the yield increased to over 50 tons per acre.

(d) Variety Trials.

The variety trials were continued in House 5. The crop weights were abnormally low due to an attack of eelworm in the soil.

The results are given in Table 5. Of the top seven, two only produced good shaped fruit, namely, the cross between Helvetia and E.S.1, and the variety Monarch.

In Houses 1 and 2 six crosses possessing a high degree of resistance to *Cladosporium fulvum* were grown. The crop weights are given in Table 6, and while they are not high they were comparable to that from other varieties in the same houses. Stirling Castle $\times$ E.S.1 $\times$ Radio, and Stirling Castle $\times$ E.S.1 $\times$ Potentate, shew the highest resistance and the first of these produces good shaped fruit. Both have been tested under commercial conditions by growers in different parts of the country and good reports have been received. With a little more improvement they should become popular varieties.

2. Cucumbers.

The cucumber investigations were restricted to an experiment on the effect of treating the young plants in the propagating house with electric light from 500 watt gas filled lamps mounted in parabolic reflectors. The light was applied from 4 p.m. to 8 p.m. each evening. In one series the intensity of the light was 280 foot candles and in another 70 foot candles. One batch of plants was left untreated as a control. Picking commenced on 19th February from both of the irradiated

Table 4.

Variety—E.S.1.

House	Plot	Treatment.	CROP YIELD IN LBS. PER PLANT						Total Tons Per Acre	Average Tons Per Acre
			June	July	Aug.	Sept.	Oct.	Total		
7	1	Sterilized with steam for 1936	1.04	2.80	2.00	0.85	0.39	7.08	53.80	49.62
	2	"	1.17	3.00	1.96	0.96	0.51	7.60	57.76	
	3	"	1.24	2.66	1.75	0.93	0.53	7.11	54.05	
	4	"	1.12	2.91	1.56	0.81	0.58	6.98	53.06	
	5	"	0.96	2.41	1.34	0.65	0.52	5.88	44.68	
	6	"	0.98	2.34	1.68	0.80	0.59	6.39	48.56	
	7	"	1.04	2.27	1.44	0.70	0.41	5.86	44.54	
	8	"	0.86	2.31	1.43	0.54	0.46	5.60	42.56	
8	1	Cresylic Acid	0.89	2.20	1.36	0.83	0.35	5.63	42.80	46.63
	3	"	0.87	2.22	1.35	0.87	0.42	5.73	43.55	
	5	"	0.27	2.33	2.22	0.89	0.94	6.65	50.62	
	7	"	0.37	2.22	2.29	0.88	0.76	6.52	49.55	
9	6	Proprietary Sterilizer	0.75	2.00	1.30	0.84	0.60	5.49	41.72	43.05
	7	"	0.84	2.04	1.33	0.75	0.40	5.36	40.73	
	2	"	0.42	2.41	2.00	0.91	0.74	6.48	49.25	
	3	"	0.35	2.14	1.53	0.65	0.66	5.33	40.48	

Table 5.

Variety	CROP YIELD IN LBS. PER PLANT							Total Tons Per Acre	Quality of Fruit : Percentage in Grade				
									A	B	C	D	E
	May	June	July	Aug.	Sept.	Oct.	Total						
Blaby × Potentate	0.10	1.95	1.62	1.06	0.51	0.30	5.54	42.10	38	7	37	4	14
Helvetia × E.S.1	0.01	1.35	1.73	1.16	0.42	0.23	4.90	37.24	72	20	1	4	2
Planters Favourite	—	0.93	1.96	1.08	0.77	—	4.74	36.02	36	7	43	4	6
Monarch	—	1.01	1.86	1.27	0.58	—	4.72	35.87	67	14	9	5	5
Mayland Excelsior	0.11	1.39	1.64	1.22	0.32	—	4.68	35.57	52	16	23	5	4
Blaby × Kondine Red	0.05	1.44	1.63	1.00	0.31	0.16	4.59	34.88	29	9	43	6	9
Bides Recruit × Potentate	—	1.16	1.73	1.04	0.43	0.22	4.58	34.81	32	8	53	3	4
Potentate × Kondine Red	—	0.68	1.87	1.40	0.35	0.28	4.58	34.81	73	14	1	4	5
Bides Recruit × Kondine Red (2)	—	0.76	1.88	1.15	0.48	0.27	4.54	34.50	57	15	16	4	8
Helvetia × Ailsa Craig	—	1.15	1.71	0.85	0.72	0.10	4.53	34.43	65	24	1	6	3
J.H. No. 1	—	0.94	2.00	0.86	0.63	—	4.43	33.67	37	6	40	2	14
Bides Recruit × Kondine Red (1)	—	0.88	1.48	0.99	0.68	0.39	4.42	33.59	55	24	9	4	7
Duvaux Radio	—	0.99	1.78	1.04	0.40	0.19	4.40	33.44	57	24	7	4	7
Duvaux Radio × Kondine Red	0.11	0.91	2.00	0.96	0.35	—	4.33	32.91	68	16	2	4	6
Radio × Trackwood	—	1.09	1.91	0.98	0.35	—	4.33	32.91	64	15	15	3	3

Table 6.

Variety	CROP WEIGHT IN LBS. PER PLANT						Total Tons Per Acre	Grade Percentage of Total				
								A	B	C	D	E
	June	July	Aug.	Sept.	Oct.	Total						
Stirling Castle × E.S.1 × Bides Recruit	0.63	2.21	1.34	0.68	0.72	5.58	42.40	80	10	2	2	3
Stirling Castle × E.S.1 × Radio	0.50	2.22	1.11	0.64	0.62	5.09	38.62	81	11	2	3	2
E.S.1 × Up-to-Date × Radio	0.35	2.54	1.18	1.05	0.73	5.85	44.48	79	11	2	4	2
Stirling Castle × E.S.1 × Potentate	0.74	2.31	0.96	0.54	0.45	5.00	37.99	70	12	9	3	4
Stirling Castle × E.S.1 × Kondine Red	1.01	2.25	1.08	0.61	0.47	5.42	41.19	66	14	7	3	6
E.S.1 × Up-to-Date × Potentate	0.53	2.05	1.19	0.59	0.41	4.77	36.25	69	13	8	3	5

series, and on 22nd February from the control beds. The crop was an unusually early one for the Station since the irradiated plants were planted in the beds on 1st January and the controls on 11th January, 1937.

The results are given in Tables 7 to 9. The irradiated plants receiving 280 foot candles produced 0.61 lbs. per sq. foot in February and 5.06 lbs. per plant in March. The plants receiving 70 foot candles produced 0.42 lbs. per plant in February and 4.66 lbs. per plant in March. The controls produced only 0.07 lbs. per plant in February but 6.47 lbs. per plant in March. Thus the benefit of the increase in February was quickly lost. In addition, the total weight of fruit picked during the season is not usually highest from the irradiated plants.

A summary of recent work at the Station on the irradiation of cucumber plants will be given later in this Report.

Unfortunately our results do not substantiate the claim that irradiation of cucumbers is a commercial proposition.

3. Lettuce.

The cultivation of Cheshunt Early Giant lettuce in warm glasshouses is increasing all over the country, and it is probably no exaggeration to say that it is the best variety for cultivation between September and March.

Two excellent crops were grown in the experimental houses, one being marketed at the end of December and the other at the end of February. Planting out in the houses before the middle of September and after the beginning of January is not recommended, because good weather in September and April may cause the plants to bolt.

Cheshunt Early Ball is also proving a good lettuce for cold frames. It is tender, hearts well, and possesses an attractive appearance. It is well worth a trial by all who specialize in cold frame work.

4. Soil Warming under Frames.

The area devoted to frames is divided into four sections, each 30 feet wide and 66 feet long. In three sections the soil is warmed by a system of small pipes through which hot water is circulated by means of an electric pump regulated by thermostats in the soil. Each section accommodates three rows of frames covered with Dutch lights, and there is also a strip of warmed uncovered land 5 feet wide and 66 feet long. The hot water pipes, 1 inch in diameter, are laid as a single flow and return loop under each frame and also under the uncovered

area, the pipes being 20 inches below the surface. The three sections are maintained at soil temperatures of 55°F., 60°F., and 65°F. respectively, the fourth or control section being unheated.

In the present series of experiments, bulbs of narcissi, Sir Watkins and Horace, and the Darwin tulip, William Copeland, were planted in parts of all the sections on 18th November, 1936. Parts were also planted with strawberries and potatoes. On 6th January, 1937, carrot seeds were sown and covered by raking in accordance with general practice. Young lettuce plants were then planted and the frames covered with lights. Soil warming commenced on 11th January, 1937.

It will be seen from Table 10 that soil warming resulted in an earlier maturity, which is particularly striking in the case of lettuce. The best heads of all came from the soil kept at 60°F., which were cut a month earlier than the unwarmed controls.

In the case of narcissus, Sir Watkins, there was very little difference between the different series, although the flowers were cut six days earlier from the soil at 65°F. than from the cooler soils while the control plants were seventeen days behind those from the soil maintained at 55°F. The flowers from all the warmed plots were good and had stalks 18 inches long, but those grown in soil at 55°F. were much better than the others. In the case of Horace, the flowers were small, while the stems were weak and tended to collapse where the soil temperature was 60°F. and 65°F. They were excellent where the soil was maintained at 55°F. and were picked eighteen days before the controls.

The soil temperatures of 60°F. and 65°F. were too high for the Darwin tulip, William Copeland. At 65°F. the stalks were very short, the flowers colouring before they had raised themselves above the leaves. This was less pronounced at 60°F., but the stems were too short for market purposes.

At a soil temperature of 65°F. the strawberries made luxuriant leaf growth and set only a few fruits; they were reasonably good in soil at 60°F., but excellent at 55°F., being picked some fifteen days before the unwarmed controls. Potatoes were a failure in all the warmed plots, although small tubers were formed in the soil at 55°F.

Carrots were best, and very good, at 55°F., and reasonably good at 60°F., but Amsterdam Forcing was the only variety to form good roots at 65°F.

The lettuce results were extremely interesting. Planted on 6th January, those on soil warmed to 65°F. were cut in approximately nine weeks, those at 60°F. were cut five days

Table 7.

Variety—"Butcher's Disease Resister."

House	Plot	Treatment	CROP YIELD IN LBS. PER PLANT						Total Tons Per Acre	Total Flats Per Foot	
			CROP YIELD IN LBS. PER PLANT								
			Feb.	March	April	May	June	July			
C D G	3	Control : no additional light	0.26	5.00	10.73	10.06	5.22	—	31.27	46.91	0.94
	3	"	—	4.96	10.75	10.28	11.94	6.28	44.21	66.32	1.34
	5	"	—	4.32	9.87	11.14	11.78	5.83	42.94	64.41	1.30
	1	"	0.05	9.98	10.57	8.98	16.86	7.86	54.30	81.45	1.64
	2	"	—	6.51	11.71	9.90	13.70	7.42	49.24	73.86	1.49
	3	"	0.08	7.40	10.38	8.40	14.57	7.84	48.67	73.01	1.47
	4	"	0.09	7.15	11.25	8.13	12.25	8.19	47.06	70.59	1.46
	2	Propagated under electric light : Treatment (a)	0.38	5.00	11.29	10.53	5.07	—	32.27	48.41	0.98
D F	2	"	0.20	5.73	9.24	9.86	12.21	5.30	42.54	63.81	1.29
	6	"	0.16	4.54	9.78	9.60	11.12	4.39	39.59	59.39	1.17
	1	"	0.46	5.13	10.55	8.79	11.47	6.10	42.50	63.75	1.29
	2	"	0.28	4.01	9.65	9.51	11.49	5.03	39.97	59.96	1.21
	3	"	0.57	4.79	9.85	9.16	9.98	3.77	38.12	57.18	1.15
	4	"	0.59	4.88	9.91	10.06	11.15	5.70	42.29	63.44	1.28
	5	"	0.41	4.14	10.75	10.31	13.07	5.34	44.02	66.03	1.33
	6	"	0.72	4.35	10.55	10.00	11.29	5.34	42.25	63.38	1.28
7 8	7	"	0.41	4.43	9.58	9.47	10.33	5.72	39.94	59.91	1.21
	8	"	0.41	4.21	10.35	8.81	11.01	4.99	39.78	59.67	1.21

Table 7 (continued).

House	Plot	Treatment	CROP YIELD IN LBS. PER PLANT						Total	Total Tons Per Acre	Total Flats Per Foot
			Feb.	March	April	May	June	July			
C	4	Propagated under electric light :	0.25	4.35	10.31	9.38	4.58	—	28.87	43.31	0.88
D	4	"	0.26	6.08	10.76	10.56	12.88	5.71	46.25	69.39	1.40
E	7	"	0.48	4.37	9.85	9.85	11.79	4.63	40.97	61.46	1.24
	1	"	0.87	4.69	7.61	7.09	9.21	3.74	33.21	48.82	1.01
	2	"	0.58	5.90	10.17	8.19	10.94	5.18	40.96	61.44	1.24
	3	"	0.81	5.43	9.69	8.82	11.55	5.39	41.69	62.54	1.27
	4	"	0.56	6.02	8.91	8.99	11.00	5.78	41.26	61.89	1.25
	5	"	0.56	4.97	9.44	9.24	11.57	5.31	41.09	61.64	1.24
	6	"	0.65	4.71	9.69	9.21	11.16	5.11	40.53	60.80	1.23
	7	"	0.91	4.83	9.70	8.28	10.55	4.78	40.05	60.08	1.21
	8	"	0.76	4.32	9.50	8.54	11.72	5.17	40.01	60.02	1.21

TREATMENT (a) 70 foot Candles 4 p.m.—8 p.m.

" (b) 280 foot Candles 4 p.m.—8 p.m.

Table 8.

Treatment	Average Crop Yield in lbs. per Plant totalled each month					
	Feb.	March	April	May	June	July
Control: no additional light	0.07	6.54	17.29	26.84	39.17	45.37
Propagated under electric light: 70 foot candles 4 p.m. to 8 p.m. ...	0.42	5.17	15.31	24.96	35.70	40.30
Propagated under electric light: 280 foot candles 4 p.m. to 8 p.m. ...	0.61	5.58	15.18	24.19	34.82	39.44

Table 9.

Treatment	Average Crop Yield per Month in lbs. per Plant						
	Feb.	March	April	May	June	July	Total
Control: no additional light ...	0.07	6.47	10.75	9.55	12.33	6.20	45.37
Propagated under electric light: 70 foot candles 4 p.m. to 8 p.m. ...	0.42	4.65	10.14	9.65	10.74	4.70	40.30
Propagated under electric light: 280 foot candles 4 p.m. to 8 p.m. ...	0.61	4.97	9.60	9.01	10.63	4.62	39.44

Table 10.

Crop	Date of Planting	Date of Marketing			
		Soil Temperature 65°F.	Soil Temperature 60°F.	Soil Temperature 55°F.	Control
Sir Watkins. ...	18/11/36	23/2/37	1/3/37	1/3/37	18/3/37
Horace	18/11/36	12/3/37	12/3/37	19/3/37	6/4/37
William Copeland .	18/11/36	12/3/37	12/3/37	19/3/37	6/4/37
Strawberries ...	18/11/36	Unsatisfactory	12/5/37	12/5/37	27/5/37
Lettuce	6/1/37	12/3/37	17/3/37	24/3/37	16/4/37
Carrots	6/1/37	—	5/5/37	5/5/37	—

later, and those at 55°F. twelve days later. The plants in the control frames were cut about three weeks later than those in soil at 55°F. The best lettuces were those at 60°F.; they were large, with solid hearts. Those at 55°F. were smaller, while at 65°F. they were large, but the hearts were looser.

As preliminary results these are highly satisfactory. They indicate that more rapid growth occurs in the warmer soils, and that when sufficient knowledge is available the process of soil warming may be of considerable service to the commercial grower.

5. Mushrooms.

At the end of the previous crop in the mushroom shed, every precaution had to be taken to destroy infection by *Mycogyne* and *Pseudobalsamia microspora*, the latter of which was present in abundance.

The shed was first cyanided by the jar method, using 1 ounce of sodium cyanide to every 1,000 cubic feet. Next the diseased beds were thoroughly saturated with formaldehyde, using a solution prepared by adding 1 part by volume of 40% formaldehyde to 49 parts of water. The shed was then closed for forty-eight hours and the old beds removed for sterilization by steaming to ensure that contamination was not left in the nursery as infection for future crops.

Afterwards the shelves and the inside of the shed were washed down thoroughly, using brushes and water from a hose. When everything was dry the shelves and inside of the shed were again soaked with formaldehyde and closed for forty-eight hours. Finally, when the formaldehyde had evaporated the shelves were treated with a large blow-lamp, moving the flame slowly over the surface of the boards to destroy any contamination which might remain. In the process any fine splinters projecting from the surface of the wood were singed.

The new compost was prepared from an excellent sample of good clean strawy manure, with which 1 ton of clean wheat straw, previously soaked in water, was added for every 20 tons of manure. At the first turning gypsum was incorporated at the rate of 1 cwt. to 3 tons of compost.

The new beds (8 inch flat beds) were made up on 1st December, 1936, spawned on 9th December, and the first mushrooms were picked on 21st January, 1937, six weeks after spawning.

The investigations conducted in 1936 in the mushroom shed shewed very clearly that diseases of this crop can be introduced in the casing soil, and it was decided to use sterilized soil for all future work.

Table 11.

Plot	Casing Soil	WEIGHT IN LBS. PER SQUARE FOOT							NUMBERS PER SQUARE FOOT							Average Wt. of each Mushroom in oz.		
		Jan.	Feb.	Mar.	Apr.	May	June	July	Total	Jan.	Feb.	Mar.	Apr.	May	June		July	Total
A2	Hoddesdon	0.40	1.66	0.96	0.59	0.40	0.20	0.07	4.28	7.23	40.14	21.51	12.04	7.59	3.44	1.43	93.38	0.73
B4	"	0.57	1.37	0.56	0.47	0.35	0.06	0.07	3.45	10.74	36.69	10.43	10.00	7.15	1.15	1.28	77.47	0.71
D2	"	0.58	1.46	0.74	0.77	0.35	0.11	—	4.01	9.98	40.43	17.57	16.26	8.86	1.95	—	95.05	0.67
E3	"	0.50	1.48	0.78	0.43	0.33	0.16	0.03	3.71	8.05	33.23	18.98	9.15	5.57	3.69	0.52	79.19	0.75
A1	Experimental Station	0.52	1.29	0.74	0.55	0.40	0.14	0.03	3.67	11.35	31.01	14.25	9.68	6.06	3.21	0.49	76.05	0.77
B1	"	0.54	1.18	0.62	0.40	0.33	0.06	0.13	3.26	11.53	29.25	13.80	7.97	5.36	1.47	2.45	71.83	0.72
D1	"	0.64	1.34	0.48	0.43	0.44	0.08	0.04	3.45	11.77	30.95	8.82	7.26	7.74	1.87	0.74	69.15	0.80
E4	"	0.66	1.12	0.62	0.53	0.25	0.18	0.04	3.40	11.96	27.96	15.92	10.99	5.15	4.04	0.99	77.01	0.71
A3	Cheshunt Common	0.70	1.11	0.69	0.49	0.34	0.18	0.05	3.56	16.46	27.73	15.71	8.88	6.17	3.29	0.74	78.98	0.72
B2	"	0.47	0.96	0.53	0.42	0.27	0.05	0.02	2.72	9.32	21.51	9.81	8.71	5.68	2.04	2.78	59.85	0.73
D3	"	1.15	1.06	0.67	0.43	0.26	0.13	0.05	3.75	13.45	29.68	14.48	11.42	4.99	2.75	0.77	77.54	0.72
E1	"	0.59	1.14	0.63	0.64	0.31	0.25	0.07	3.63	10.10	26.92	13.18	13.43	5.82	4.13	1.18	74.76	0.77
A4	Nazeing...	0.61	1.26	0.73	0.32	0.32	0.08	0.03	3.35	12.25	30.10	15.72	6.61	7.89	1.75	0.49	74.81	0.74
B3	"	0.43	1.13	0.63	0.39	0.29	0.08	0.10	3.05	8.03	20.33	12.87	8.00	5.82	1.81	1.92	58.78	0.83
D4	"	0.54	1.29	0.64	0.35	0.33	0.06	0.01	3.22	9.42	35.88	13.15	7.72	7.85	1.06	2.29	77.37	0.66
E2	"	0.59	0.90	0.61	0.47	0.29	0.16	0.01	3.03	14.51	24.74	18.61	8.80	5.93	3.53	0.20	76.32	0.63

Table 11 (continued)

Plot	Casing Soil	WEIGHT IN LBS. PER SQUARE FOOT							NUMBERS PER SQUARE FOOT							Average Wt. of each Mushroom in oz.		
		Jan.	Feb.	Mar.	Apr.	May	June	July	Total	Jan.	Feb.	Mar.	Apr.	May	June		July	Total
C1	Hoddesdon ...	0.47	1.40	0.74	0.37	0.21	0.01	—	3.20	9.31	27.15	13.00	7.28	2.49	0.15	—	59.38	0.86
C3b	" Sodium fluoride added to bed ...	0.43	1.61	0.55	0.46	0.12	0.03	—	3.20	10.50	35.92	7.33	9.33	3.11	0.66	—	66.85	0.77
C4	" Naphthalene	0.35	1.45	0.73	0.30	0.17	—	—	3.00	7.38	30.33	14.54	3.74	3.69	—	—	59.68	0.80
C2a	Cased 9 days after spawned	0.35	0.65	0.51	0.13	0.08	—	—	1.72	6.47	13.39	8.68	2.21	1.76	—	—	32.51	0.83
C2b	Hoddesdon ...	0.33	0.94	0.82	0.36	0.42	0.03	—	2.90	7.77	16.00	19.82	6.61	10.00	1.05	—	61.25	0.76
C3a	"	0.46	1.22	0.62	0.37	0.22	0.03	—	2.92	11.83	31.94	16.00	10.88	7.77	0.55	—	78.97	0.60
F1	"	0.66	0.86	0.59	0.06	—	—	—	2.17	17.46	16.26	17.03	1.38	—	—	—	52.13	0.66
F2a	"	0.62	1.28	0.55	—	—	—	—	2.45	13.78	18.89	23.94	—	—	—	—	56.61	0.69
F2b	"	0.59	1.11	0.57	0.18	—	—	—	2.45	10.38	23.03	18.04	2.66	—	—	—	54.11	0.72
F3a	Charcoal 33 Soil 66	0.58	—	—	—	—	—	—	0.58	11.59	—	—	—	—	—	—	11.59	0.80
F3b	Granite Chips ...	0.18	1.28	0.03	—	—	—	—	1.49	2.66	16.96	0.85	—	—	—	—	20.47	1.16
F3c	Peat 50 Soil 50...	1.30	1.27	0.75	—	—	—	—	3.32	26.78	27.11	30.84	—	—	—	—	84.73	0.62
F3d	" 100	0.75	0.06	—	—	—	—	—	0.81	8.77	0.77	—	—	—	—	—	9.54	1.30
F4a	Stones 50 Soil 50	1.27	1.20	0.66	—	—	—	—	3.13	24.21	34.99	19.73	—	—	—	—	78.93	0.63
F4b	Stones 100	0.09	1.36	0.35	—	—	—	—	1.80	18.55	39.77	4.71	—	—	—	—	63.03	0.46
F4c	Sand 50 Soil 50	0.65	2.10	0.91	—	—	—	—	3.66	11.79	68.61	17.33	—	—	—	—	97.73	0.60
F4d	Sand 100	0.02	0.65	0.71	—	—	—	—	1.38	0.42	20.17	10.17	—	—	—	—	30.76	0.76

In 1937 the problem of the casing soil was examined further. Soils from four different sources were used in plots randomised on four shelves, namely, two middle and two top shelves. They were as follows:—

- (a) Cheshunt Research Station soil—a light loam moderately rich in organic material.
- (b) Nazeing Common soil—a light loam free from organic matter.
- (c) Cheshunt Common soil—heavy soil, rich in organic material.
- (d) Hoddesdon soil—a brick earth, heavy and free from organic material.

All the soils were sterilized by steam at a temperature of 212°F., steam being passed into the soil for thirty minutes.

The results detailed in Table 11 give the number and weight of mushrooms picked from each square foot of bed surface.

It will be seen that the heaviest average yield occurred when the heavy brick earth soil from Hoddesdon was used and the lowest crop from the light soil from Nazeing, while between these limits came the crops where the Cheshunt Common and Experimental Station soils were used. There was little difference in the average weight of each mushroom, although they were slightly heavier on the Experimental Station and Cheshunt Common soils, which were moderately rich in organic material. It was noticeable, however, during the crop that the mushrooms from these two soils possessed longer stalks than those from Hoddesdon and Nazeing soils. An excellent crop was obtained and the results indicate that the weight per square foot and the general appearance and size of individual mushrooms varies with different types of casing soil, although the factors which cause this variation are as yet unknown. Water-holding capacity, ease of wetting, the amount of organic matter, and the ease with which gases diffuse through the layer of casing soil are obvious factors.

The two bottom benches were allotted to a number of isolated experiments of a preliminary nature. On one section, C4, the compost was mixed with pure white flake naphthalene immediately before making the bed, at the rate of 3 lbs. per ton, and in another, C3b, sodium fluoride was added at the same rate. In neither case was the yield affected. In one section, C2a, the casing soil was applied seven days after spawning, whereas the other beds were not cased until twenty-one days after spawning. In this case mushrooms were picked earliest, but the crop was one of the lowest in the house, namely, 1.72 lbs. per square foot.

On the other bottom shelf a number of different materials were used for casing the beds, namely, sand, sand and soil, stones, stones and soil, granite chips, peat, peat and soil, and finally charcoal and soil.

These experiments, although conducted on a very small scale, proved extremely interesting. Sand (1.48 lbs. per square foot), stones (1.8), peat (0.81), and granite chips (1.49) all produced a low yield, although the granite chips and peat produced very heavy mushrooms.

The addition of one-third wood charcoal in the casing soil produced an excellent show of good white mushrooms at first, but unfortunately they were brown in the centre of the stem and cap. This injury seemed to be physiological in nature, for isolations from the brown tissue proved to be sterile.

Sand and soil, stones and soil, and peat and soil in equal proportion gave heavy yields of good mushrooms. The crop obtained by the end of the first ten days was 1.30 lbs. per square foot where the peat and soil mixture was used, 1.27 in the case of stones and soil, and 0.65 with the sand and soil casing mixture. At the end of March these small plots were re-cased with different mixtures of peat, stones, and soil, but the result was unsatisfactory and the records are not included in the Table.

The mass of mushrooms produced on these beds resulted in long stalked small forms, and the results cannot be taken as a guide to commercial work, but they are valuable because they illustrate very clearly the variation in crop weight and form of mushroom which can be induced by using different types of material for casing the beds. Further, the increase in earliness and crop weight suggests the need for a good deal of work on the effect of different mixtures of stones, peat, sand and soil for casing mushroom beds.

Trials have been arranged in co-operation with many growers and the work will be continued.

2. Plant Diseases.

The number of enquiries dealt with each year continues to grow. In 1937 497 specimens were received and reported upon. They may be roughly classified as follows:—

General Mycology (Tomatoes, etc.)	...	264
Virus Diseases		125
Flower Diseases		90
Vegetable Diseases		18

Diseases brought to the Station during the year and not previously reported are listed below:—

Host	Disease	Cause
Acroclinium	Downy mildew ...	<i>Peronospora sp.</i>
Anemone	Rhizome rot... ..	<i>Bacillus carotovorus.</i>
Apple	Powdery mildew ...	<i>Podosphæra leucotricha.</i>
Asparagus sprengeri ...	Crown rot	<i>Fusarium sp.</i>
Asplenium	Leaf blotch	<i>Aphelenchoides olesistus.</i>
Broccoli	Stalk rot	<i>Bacillus carotovorus.</i>
Cabbage	Club root	<i>Plasmodiophora brassicæ.</i>
Canna	Rhizome rot... ..	<i>Fusarium sp.</i>
Chrysanthemum	Leaf spot	<i>Botrytis cinerea.</i>
Chrysanthemum	Root rot	<i>Fusarium sp.</i>
Cineraria... ..	Root rot	" "
Crassula falcata	Wilt	" "
Cyclamen	Soft rot	<i>Bacillus carotovorus.</i>
Dahlia	Soft rot of tuber ...	" "
Erica spp.	Powdery mildew ...	<i>Oidium ericinum.</i>
E. hyemalis	Grey mould... ..	<i>Botrytis cinerea.</i>
E. hyemalis	Wilt	<i>Phytophthora cactorum</i>
Gaillardia	Mosaic	<i>Cucumber virus 1.</i>
Geranium	Leafy gall	<i>Pseudomonas fascians.</i>
Hydrangea	Oedema	Non-parasitic.
Iris... ..	Soft rot	<i>Bacillus carotovorus.</i>
Iris... ..	Grey bulb rot	<i>Sclerotium tuliparum.</i>
Lettuce	Root knot	<i>Heterodera marioni.</i>
Lettuce	Soft rot	<i>Bacillus carotovorus.</i>
Lettuce	Ring spot	<i>Marssonina panattoniana.</i>
Lilium longiflorum ...	Mosaic	<i>Virus, Cucumber virus 1 type.</i>

Host			Disease		Cause	
Lilium tenuifolium	...	...	Bulb rot	...	...	<i>Aphelenchoides olesistus.</i>
Lonicera nitida	...	...	Wilt	...	...	<i>Verticillium sp.</i>
Marguerite	...	...	Leaf spot	...	...	<i>Ramularia bellunensis.</i>
Mushroom	...	...	Pink mould	...	...	<i>Dactylium dendroides.</i>
Narcissus	...	...	Leaf eelworm	...	...	<i>Anguillulina dipsaci.</i>
Narcissus	...	...	Basal rot	...	...	<i>Fusarium bulbigenum.</i>
Narcissus	...	...	Leaf scorch	...	...	<i>Stagonospora curtisii.</i>
Nicotiana affinis	...	...	Mosaic	...	...	<i>Potato virus X.</i>
Onion	...	...	Downy mildew	...	...	<i>Peronospora schleidenii.</i>
Pea	...	...	Root disease	...	...	<i>Heterodera schachtii.</i>
Pea	...	...	Root rot	...	...	<i>Fusarium sp.</i>
Peach	...	...	Leaf curl	...	...	<i>Taphrina deformans.</i>
Peach	...	...	Powdery mildew	...	...	<i>Sphaerotheca pannosa.</i>
Pteris	...	...	Grey mould	...	...	<i>Botrytis cinerea.</i>
Polyanthus	...	...	Mosaic	...	...	<i>Cucumber virus 1.</i>
Pyrethrum	...	...	Root knot	...	...	<i>Heterodera marioni.</i>
Rose	...	...	Crown gall	...	...	<i>Bacterium tumefaciens.</i>
Stock	...	...	Downy mildew	...	...	<i>Peronospora sp.</i>
Stock	...	...	Mosaic and flower breakng.	...	...	<i>Cabbage mosaic virus.</i>
Tomato	...	...	Root disease	...	...	<i>Heterodera schachtii.</i>
Viola	...	...	Collar rot	...	...	<i>Phytophthora cactorum</i>

1. Cucumber Root Rot.

P. H. WILLIAMS.

The investigation of the causes of cucumber root rot has been continued. As previously reported a large number of bacteria and fungi have been isolated from diseased roots. Among these organisms species of *Fusarium* are the most important since they are being isolated constantly from diseased roots. For the present the work is being confined to these fungi.

It is impossible to say how many species of *Fusarium* have been isolated, but parallel cultures on various media have indicated that at least six may be present.

Inoculation experiments.

In the Annual Report for 1936 mention was made of a method of growing the plants in water culture in order to facilitate direct inoculations of the hypocotyl and roots. In

practice it has been found that water condenses on the surface of the inoculated tissues and leads to contamination of the wound by bacteria and fungi and therefore the method has been abandoned.

As an alternative, a modification of a method used by Garratt in investigations of root rot of wheat has been adopted. This method permits fairly accurate control of the water content of the soil and should prove valuable in investigating the action of the fungi under varying conditions.

In this method sterilized soil is air dried, sifted through a 3 mm. sieve and its water capacity determined. Weighed amounts are placed in a wide mouthed glass bottle and sufficient water added to bring the soil to any desired water content. The soaked seeds are then sown and covered with sand saturated with water. Enough sand is used to bring the total weight to some convenient figure, and it is then only necessary to add sufficient water from time to time to bring the weight back to its former value. In summer, when growth is active, allowance must be made for the weight of the plant.

The fungi are grown in sand containing 3% of oatmeal. These cultures are mixed with the dry soil before it is put in the bottle. The even distribution of the fungi obtained in this manner enables them to compete more effectively with the inevitable contaminants, and also avoids mechanical injury to the roots such as is bound to occur when pieces of culture are inserted in the soil. Bacteria may be inoculated into the soil either as cultures in broth or suspended in sterile water. It has been found that in summer the bottles become filled with roots in twenty-one days after germination. During longer periods the plants become hard and the mat of roots become so difficult to handle that a number of roots are destroyed in the process of washing. It has been found convenient to inoculate five plants with each organism and to examine two of them seven days after germination, two after fourteen days and one after twenty-one days.

Using this method, several organisms have been tested for pathogenicity, the soil being maintained at 80% of saturation. These organisms included three bacteria and seven forms of *Fusarium*. In no case was any evidence of pathogenicity obtained. Later in the season, however, evidence was obtained that one of the *Fusarium* forms previously used (No. 35) would cause damage at higher soil humidities, injury to roots occurring in saturated soil, and in soil at 90% and 80% saturation. The fungus was successfully re-isolated from the diseased roots. This suggests that many of the organisms isolated are weak pathogens and cause injury only under conditions unfavourable to the growth of the cucumber.

So far as soil conditions are concerned, confirmatory evidence for this view was obtained in an experiment conducted in pots. In this experiment the soil in half of the pots was inoculated with a culture of *Fusarium* (No. 35). Each half was divided into three lots, one lot was kept as dry as possible and was only watered when the plants showed signs of flagging. The second lot was placed in saucers of water and the third given normal treatment. The plants were examined at seven, fourteen, and twenty-one days after germination. Those receiving normal treatment remained healthy, as did those which were grown in sterilized soil and kept reasonably dry. In the plants growing in inoculated soil and kept dry, two roots shewed slight yellowing. The roots of the plants growing in wet soil shewed browning and rot after only seven days. Those in the inoculated soil were more severely affected. At the later examinations it was evident that the roots had died as soon as they penetrated the waterlogged soil at the bottom of the pot. Again the damage was more severe in plants growing in soil infected with the *Fusarium*, and the fungus was successfully re-isolated from a number of roots. It seems, therefore, that unfavourable physical conditions in the soil may cause the death of cucumber roots without the presence of an actively parasitic fungus or bacterium, and this aspect of the work is being followed up.

2. Mushroom Diseases.

P. H. WILLIAMS.

A large number of specimens have been received during the past two years in which the caps of the mushrooms shewed more or less superficial browning. Occasionally the browning may penetrate the flesh. In many cases the fruit body remains small, but it may also be flaccid and the interior a pale brown in colour. The condition appears to be the same as that described by Wood as "Wilt" or "Damping Off," and attributed by him to infection by *Fusarium oxysporum* and *F. solani*, var. *Martii*.

Some isolations from these mushrooms have yielded *Fusarium* while others have contained bacteria. A number of these organisms have been inoculated directly into mushrooms when in the "button" stage. In these inoculations the organisms have been pricked into the flesh or placed in contact with the fruit body, but in no case has infection resulted. An attempt to reproduce the disease by inoculating the casing soil with a culture of a *Fusarium* was also unsuccessful. It

may be noted that Wood was unable to obtain infection under similar conditions. In his successful experiments he compressed spawn into dishes and then cased it with infected soil. It may be suggested that these conditions of growth rendered the mushrooms more susceptible to attack by the fungi and that the primary cause of the trouble under nursery conditions is to be found in conditions of the bed which are unfavourable to the mushroom.

During 1937 several specimens have been received of mushrooms attacked by *Dactylium dendroides*, a fungus which has not been previously reported from this Station. This fungus is the conidial stage of *Hypomyces rosellus*, and has been frequently recorded as attacking fungi such as *Cantharellus aurantiacus*, etc., out of doors.

On mushroom beds the fungus produces a white fluffy growth with a pink or purple tinge. It grows over the developing mushrooms and destroys them, but apparently does not cause a rapid decay. In culture the fungus grows rapidly and on media containing sugars it is bright pink with a red colour in the medium. The spores are borne on verticillately branched hyphæ and are large with three or more septa.

So far attempts to establish the fungus in experimental mushroom cultures have not been successful, probably because the moisture conditions in the house are not sufficiently high. There has therefore been no opportunity to study its habits in detail. It is reported, however, to be most troublesome in beds from which old stem butts, etc., are not removed. In the cases so far dealt with, removal of the infected mushrooms and casing soil have been successful in controlling it. In severe cases it is necessary to spray the small isolated clumps with formaldehyde.

3. The Spotting of Tomato Fruits by *Botrytis*.

G. C. AINSWORTH AND E. OYLER.

In last year's Report (pp. 64—69) Read shewed that the spotting of tomato fruits, for which the name "Water Spot" was proposed, was caused by the grey mould fungus, *Botrytis cinerea* Pers., and further experiments carried out to examine in greater detail the conditions necessary for spotting have confirmed this observation.

The spots, described in last year's Report, arise in the following manner: An air-borne *Botrytis* spore comes to rest on the surface of a tomato fruit (hence spotting is more

frequent at the calyx end of a fruit where spores can lodge most easily), and if conditions of high humidity should occur, so that a film of moisture forms on the fruit, the spore germinates and the germ tube penetrates the fruit. With the return of drier conditions the sporeling dies, and so does not continue its growth into the fruit to cause the well-known *Botrytis* soft rot, but the fungal germ tube which penetrates the fruit secretes a pectinase enzyme able to disintegrate cell walls, and it is the diffusion of this enzyme outwards from the site of penetration which causes the ring to develop around the central spot, marking the place where the fungus entered.

Experiments have shewn small young fruit to be more susceptible to spotting than larger fruit in which the walls of the epidermal cells have become greatly thickened and are able to resist the fungus, that there is a slight difference in varietal susceptibility which is probably also related to differences in structure of the epidermal cells, and that turgid fruit are more easily spotted than fruits not fully turgid. A film of moisture on the fruit was shewn to be essential for spotting, which was found to occur when moist conditions were at the optimum for as short a period as four hours.

Although similar spots were produced by other species of *Botrytis* (*B. allii*, *B. tulipae*, and *B. fabae*) no evidence was obtained that certain other fungi, including *Cladosporium fulvum*, caused spotting.

Attempts to reproduce the spotting by using an enzyme prepared from *Botrytis* germ tubes were not altogether successful. The brown central puncture could be reproduced but only rarely did a ring develop around the puncture on a green unripe fruit, although a distinct green spot developed around the puncture as the fruit ripened. This failure to produce typical spots experimentally with the enzyme may perhaps be explained by the facts that the concentration of the enzyme preparations used probably differed from that of the enzyme naturally secreted by the germ tube, and by the relatively crude method of using a fine pin to puncture the epidermis.

As regards control of the disease the recommendations made in last year's Report can only be repeated. *Botrytis* spores and excessive moisture are necessary before spotting can occur. The source of *Botrytis* spores is usually infected snags and plant debris resulting from careless pruning. Excessive humidity, which besides being essential for spotting encourages *Botrytis* rot and produces an abundance of *Botrytis* spores, is often the result of incorrect ventilation, so that the

occurrence of the spotting in glasshouses suggests faulty cultural methods. Thus, control is largely a matter of employing the best horticultural practice when conditions are such that spotting is unlikely to occur on a large scale.

4. *Verticillium* Wilt of *Chrysanthemums*.

E. OYLER.

A widespread disease of chrysanthemums caused by *Verticillium* sp., has increased rapidly during the past few seasons. Many varieties are attacked, including Ace, Balcombe Beauty, Golden Favourite, Liberty, Pink Consul, Rose Precoce and White Favourite.

The symptoms of the disease appear towards the end of July, becoming more severe in October and November. The plants are stunted in growth, particularly at the top, the leaves become limp and yellow from the base of the stem upwards and in severe attacks the whole plant wilts. Infection may be restricted to one side of the plant or occasionally only one half of the leaf may be infected, when yellowish green or bright yellow blotches appear spreading from the margin inwards. The infected leaves later turn brown and hang down along the stem. At this stage the symptoms are frequently confused with those caused by eelworm, but whereas in eelworm attack the lesions are angular, well defined and limited by the veins, the leaves of plants infected with *Verticillium* shew more diffuse lesions.

When the stems are cut open a brown discolouration of the wood is frequently seen at the base of the plant, extending upwards into the branches. The discolouration of the wood may be pale pink to reddish brown and may be confined to the base of the plant, or *it may be absent*. The roots of infected plants appear to be healthy.

Isolations made at intervals from the base to the top of infected plants all yielded a species of *Verticillium*, but none was isolated from the roots. The fungus was also isolated from cuttings shewing browning of the wood and from apparently clean cuttings.

In culture the fungus produced a sparse aerial mycelium bearing conidiophores and numerous black pseudo-sclerotia, which formed a crust on the surface of the medium, suggestive of *V. dahliae*.

Tomato plants, in size 60 pots, were inoculated with pure cultures of the fungus. After three to four weeks the plants appeared stunted in growth compared with the controls and *Verticillium* was re-isolated from the brown wood an inch above the point of inoculation.

The disease is spread through infected cuttings, therefore plants suspected of infection by *Verticillium* should be destroyed after flowering.

A full investigation of the disease is being made.

5. *Phytophthora* Wilt of Heaths.

E. OYLER.

In July 1936, diseased plants of *Erica hyemalis* were received at the Station. They shewed the typical symptoms of *Phytophthora* wilt first described in this Report for 1934. Two fungi were isolated, *Phytophthora cinnamomi* and a second species of *Phytophthora* which differed from the original pathogene morphologically and in its host range. This fungus was identified by Mr. S. F. Ashby of Kew, as *P. cactorum* Leb.

When inoculated into heath plants this fungus produced symptoms indistinguishable from those produced by *P. cinnamomi*. The fungus was re-isolated and in most of the experimental work the culture employed had been re-isolated from *Rhododendron ponticum*. This plant is not infected by the heath strain of *P. cinnamomi*, and therefore any chance of contamination by that fungus was avoided.

INOCULATION EXPERIMENTS. Plants of *E. hyemalis* growing in size 60 pots were inoculated with both *Phytophthoras*. Points of inoculation were the stems at soil level, branches and compost in the pots, and the results are summarised in Table 1.

In July inoculated branches wilted in five days and in September in five to ten days after inoculation with both fungi. Plants inoculated at soil level with *P. cactorum* wilted in fifteen to seventeen days, whereas those inoculated with *P. cinnamomi* wilted in ten days. In October wilting occurred more rapidly in plants inoculated with *P. cactorum*. Plants growing in compost inoculated with *P. cinnamomi* wilted in thirty-one days as compared with forty-one days for *P. cactorum*. 92% of the inoculations with *P. cinnamomi* and 25% of those with *P. cactorum* were successful. These results indicate that *P. cinnamomi* is the more virulent species.

OTHER HOST PLANTS. Inoculation experiments shewed that *P. cactorum* has a wider host range than *P. cinnamomi*. The results are given in Table 2.

Table 1.

Inoculation of *Erica hyemalis* with *Phytophthora* spp.

Series.	Fungus.	Type of Inoculation.	No. of days before wilting occurred
September.	1 <i>P. cinnamomi</i>	Branch	5-10
	<i>P. cactorum</i>	"	5-10
	2 <i>P. cinnamomi</i>	Stem at soil level ...	10
	<i>P. cactorum</i>	" " " " ...	15-17
October.	3 <i>P. cinnamomi</i>	" " " " ...	29
	<i>P. cactorum</i>	" " " " ...	18-50
	4 <i>P. cinnamomi</i>	Compost	31
	<i>P. cactorum</i>	"	41

The organism was able to infect all plants susceptible to *P. cinnamomi*, i.e., Antirrhinum, beech, broad bean, Calceolaria, *Nicotiana glutinosa*, Schizanthus, and stocks, and to cause a fruit rot of apple and tomato. In addition it is able to rot the carrot, pear, and potato, to produce local infection in Gloxinia, *N. tabacum*, *Primula obconica*, *Solanum capsicastrum*, and strawberry, and to destroy peas, *Rhododendron ponticum*, and tomato seedlings. Negative results were obtained with Azalea, China aster, Begonia, Coleus and older tomato plants.

P. cactorum differs from *P. cinnamomi* by producing both amphignous and paragynous antheridia and also papillate zoosporangia. The oogonia and zoosporangia are smaller than those produced by *P. cinnamomi*, and whereas the latter only forms zoosporangia in non-sterile liquids, the former produces them in sterile water.

Wilted heaths have been examined at different times during the past three years and only in one batch of plants have both the species of *Phytophthora* been observed. From this it appears that *P. cinnamomi* is the usual cause of wilt.

CONTROL. The fungus can be controlled by the methods recommended for *P. cinnamomi*.

6. A Leaf Spot of Marguerites.

E. OYLER.

Ramularia bellunensis was first described by Spegazzini on *Chrysanthemum parthenium* in Italy in 1897. It has since

Table 2.
Inoculation of other hosts with *P. cactorum*.

Host.	Method of Inoculation.			No. Inoculated.	No. Infected.	Type of Infection.
Antirrhinum ...	Stem...	...	...	12	7	Wilt in 2-7 days; plants killed.
Apple ...	Fruit...	...	...	6	6	Complete firm brownish-grey rot in 10 days.
Beech ...	Branch	...	...	6	6	3 branches dead in 2 months; 3 shewed brown-ing of the wood.
Broad bean ...	Stem...	...	...	10	10	Stems turned black and plants wilted in 5 days.
Calceolaria ...	Stem...	...	...	11	10	Wilt in 4-5 days.
Carrot ...	Root...	...	...	12	12	Soft rot in 3 days.
Gloxinia...	Petiole and flower stalk...	...	...	12	9	Young flower stalks rotted in 3 days. Infection local.
<i>Nicotiana glutinosa</i> ...	Stem...	...	...	15	9	Slight browning of the stems; galls formed at point of inoculation.
<i>N. tabacum</i> ...	Stem...	...	...	3	3	Very slight stem infection.
Pea ...	Stem...	...	...	10	10	Wilt in 3-11 days; plants killed.
Pear ...	Fruit...	...	...	1	1	Complete rot in 11 days.
Potato. ...	Tuber	...	...	6	6	Black rot in 4 days.
<i>Primula obconica</i> ...	Stem and petiole	...	...	19	9	Local infection.
<i>Rhododendron ponticum</i> ...	Branch	...	...	12	12	Wilt in 7-12 days.
Schizanthus ...	Stem...	...	...	13	12	Wilt in 4 days; plants killed in 12-14 days.
<i>Solanum capsicastrum</i>	Stem...	...	...	12	11	Local infection, plants stunted.
Stock ...	Stem...	...	...	12	12	Local infection.
Strawberry ...	Petiole and runner	...	...	10	5	Local infection of runners.
Tomato ...	Stem...	...	...	18	4	Stem rot in 14 day-old plants. Older plants not infected.
Tomato ...	Fruit...	...	...	6	6	Green and ripe fruits rotted in 5 days.

been described by Voglino, in Italy, as the cause of leaf-wilt of *C. frutescens*. The fungus has not previously been recorded on Marguerites in Great Britain.

In December, 1936, and February, 1937, Marguerites infected with a "leaf-mildew" were examined. Leaves were attacked at all stages of development. Irregular greyish-brown spots first appeared at the tips and along the margins of the leaves on the lower surface. These spots later became brown with a darker brown margin. Colourless spores were produced in the centres of the spots on both surfaces of the leaf. The lesions spread inwards towards the midrib until the whole leaf became brown and withered. Septate hyphae were present in the leaf tissues. Below the stomata these hyphae branched to form a stroma from which groups of conidiophores grew out through the stomata. Later the conidiophores were not confined to the stomata but grew out of the epidermal cells.

The fungus was identified by Miss Wakefield, of Kew, as *Ramularia bellunensis* Speg.

Pure cultures of the fungus when placed on healthy Marguerite leaves caused a leaf-spot when the plants were in a damp shaded position in February and March. No infection occurred under lighter, well ventilated conditions, or in inoculation experiments carried out later in the year.

Cultures were exposed to the light for varying intervals to determine whether length of day influenced spore development. No spores were produced in any of the cultures.

Experiments to determine whether temperature influenced spore development were also unsuccessful.

7. Anther Smut of the Perpetual-Flowering Carnation.

H. L. WHITE.

A report of this disease appeared in the Annual Report for 1936. Systemic infection in 100% of cases has since resulted from the taking of cuttings from diseased plants. The presence of the fungus in the cutting does not affect rooting nor is there any delay in the development of the plant. At the request of a nurseryman, who found in a field adjacent to his nursery the Tall Oat Grass (*Arrhenatherum elatius*) infected with *Ustilago perennans*, attempts were made to infect the Carnation with this organism. These, as expected, were unsuccessful. A number of experiments set up to elucidate the mode of infection of the fungus are not sufficiently advanced to warrant discussion.

8. Diseases of Beans in Glasshouses.

H. L. WHITE.

During the early part of the year a survey was made of the diseases of beans growing in glasshouses in a prominent early bean district, visits being paid to ten nurseries. Three diseases of economic importance were noted: (1) Halo Blight, a bacterial disease caused by *B. medicaginis* (five nurseries); (2) Foot Rot, attributed provisionally to *Fusarium solani*, *Martii* (six nurseries); (3) Mosaic (two nurseries). The relative incidence of these diseases may be roughly seen in Table 1.

Table 1.

					Foot Rot.	Halo Blight.	Mosaic.
Nursery No. 1	...	...	...	...	x	—	—
" " 2	...	...	...	...	xxx	x	—
" " 3	...	...	...	...	xxx	—	xx
" " 4	...	...	...	...	—	xx	—
" " 5	...	...	...	...	xx	—	—
" " 6	...	...	...	...	x	x	—
" " 7	...	...	...	...	—	xx	—
" " 8	...	...	...	...	x	x	—
" " 9	...	...	...	...	—	—	—
" " 10	...	...	...	...	—	—	xxx

x Slight attack of disease.

xx Moderate.

xxx Severe.

Halo Blight.

This disease has been recorded in the Annual Report for 1936, in which the importance of control of the disease by the use of clean seed was emphasized. Further observations pointing to seed transmission of the disease have since been made. In one case plants from seed derived from two sources were planted in the same house. One batch of plants came up clean while about 10% of the other batch shewed typical lesions surrounded by a halo.

In many cases the halo spots on one of the first pair of true leaves were matched on the corresponding leaf by halo spots in positions which must have been contiguous when the leaves unfolded. The symptoms appear somewhat different on different nurseries and it is possible that this is due to different temperature conditions, plants growing at low temperatures developing well-marked haloes while under warmer conditions irregular reddish-brown streaks and markings on the leaves are more frequent.

Mosaic.

Observations of the incidence of Bean Mosaic confirm that the disease is seed transmitted. Observations made in one case at three fortnightly intervals on the development of the disease, apparent to the extent of 20% in young plants, failed to disclose further spread, the incidence at the end of this period being only 24%. Certain plants appeared to grow out of the disease at an early age while others developed the disease later, the general distribution of affected plants being, however, not indicative of spread from infection centres. The symptoms comprise (1) Mottling; (2) Appreciable stunting (reduction in height of twenty infected plants being $23\% \pm 3\%$ S.E.); (3) Appreciable reduction in leaf area. (4) Distortion of leaves, especially puckering and blistering of tissues bordering the main vein and narrowing of the angle formed by the junction of the leaf margins with the petiole.

Foot-Rot.

Unlike the other diseases referred to Foot Rot does not appear to be seed transmitted. The isolation of the organisms concerned presents unusual difficulty, and further work must be carried out in order to determine if one or several organisms are involved.

9. Virus Diseases.

G. C. AINSWORTH.

(a) Lettuce Mosaic.

Lettuce mosaic, which was briefly noted in last year's Report, has been the subject of further investigation during the year and although the study of this disease is still unfinished the important fact that the virus is seed-transmitted has been established.

In the past, investigators in both Europe and America have claimed that lettuce "mosaic" was seed-transmitted but it is not quite certain whether the lettuce mosaics which were the subject of these investigations are the same as that occurring in Great Britain as the responsible virus has never been described. It has, however, been established that the disease investigated at Cheshunt is the same as that described by Ogilvie in the West of England (see Long Ashton Research Station Reports for 1933-36) and the properties of the virus, which have now been determined, will be described in a later publication.

Seed, saved during the summer of 1936 from individual mosaic diseased plants, was sown during the spring and summer of 1937, in seed boxes, containing sterilised soil, at

the rate of fifty seeds per box. The work was carried out in a greenhouse kept free from insects and the seedlings were examined at frequent intervals and any diseased plants carefully removed. Three different varieties of infected lettuce seed were employed and seed transmission occurred in each case. The results, including the numbers of control seedlings raised, are summarised in Table 1, from which it can be seen that approximately 5% of the seedlings raised from infected seed shewed symptoms of mosaic.

Table 1.

Seed transmission of Lettuce Mosaic.

Variety.				No. of Plants Raised.	No. Diseased.	Percentage.
INFECTED SEED.						
Trocadero	...	...	...	1,030	57	5.54
Feltham King	...	...	...	667	41	6.15
Lobjoit's Dark Green Cos ...	...	...	...	131	3	2.30
Total	...	...	...	1,828	101	5.55
HEALTHY SEED.						
Trocadero	...	...	...	327	0	0
Cheshunt Early Giant	...	...	...	345	0	0
Total	...	...	...	672	0	0

No symptoms of disease appeared on the seed leaves but diseased plants were slightly stunted and could be recognised by a distinct mottling of the second or third foliage leaf. To prove that the seedlings were attacked by mosaic, healthy lettuce plants inoculated from diseased seedlings developed typical mosaic symptoms, and tests shewed the virus obtained from the seedlings to be similar to that with which the seed plants were infected. It was usual to grow the plants on in the boxes to the seven to nine-leaf stage, but sometimes representative samples were transferred to pots and grown to larger size. No plant which appeared healthy at the four-leaf stage subsequently developed mosaic.

The available evidence suggests that infected seed is the principal source of mosaic disease in lettuce plantings under glass and that aphides are responsible for the subsequent spread of the disease. An initial infection of 5% would be quite sufficient to cause very considerable damage to a crop when conditions were such that aphid activity was at an optimum, so the use of clean seed is of the greatest importance. Infestation by aphides is rarely serious apart from the damage caused by the aphides themselves when the infestation is heavy, if the plants are free from mosaic virus. The possibility, however, must be borne in mind that aphides may introduce the virus into the crop from susceptible weeds.

Provided virus-free seed is used, or the seedlings are carefully examined before being transplanted, there appears to be no reason why mosaic should prove a serious disease, or be difficult to control, in glasshouses where aphides can be relatively easily eradicated. In the field, where aphid attack is more difficult to combat, mosaic is likely to prove more troublesome although the damage can be reduced to a minimum by rogueing mosaic-diseased plants at an early stage and by planting at such times and in such situations that the likelihood of aphid attack is minimised.

(b) Lily Mosaic.

Shortly after Price, in America (Phytopathology, XXVII., p. 138 (abstract) and pp. 561-9, 1937), had published evidence to show that the virus of the lily mosaic was related to *Cucumber virus 1*, which is the cause of yellow-mottle mosaic of cucumber, plants of *Lilium longiflorum* shewing a splitting of the flowers and other symptoms of mosaic were received for examination. Inoculation tests to tobacco (var. White Burley) and zinnia confirmed the conclusion that lily mosaic virus and *Cucumber virus 1* are closely related types but, in the writer's present opinion, lily mosaic virus differs sufficiently from the type *Cucumber virus 1* to justify its designation as a special strain.

Cucumber virus 1 was also detected in a Gaillardia plant from Scotland and in Polyanthus plants from Aberystwyth, received from Miss K. Sampson, and the viruses obtained from these plants differed in no way from the type *Cucumber virus 1*. The Gaillardia shewed a slight mosaic mottling of the leaves and the leaves of the Polyanthus shewed a rather indefinite mottling together with numerous minute necrotic spots. Both these records were new host records from this Station and *Cucumber virus 1* in Gaillardia is a new record for the country.

(c) Tobacco Necrosis.

In 1935 K. M. Smith and Bald, working at Cambridge, described a virus (*Nicotiana virus 11*, Smith and Bald, Smith's Text Book of Plant Virus Diseases, pp. 265-9, 1937) affecting greenhouse grown tobacco, tomato, and other plants, and during the year the presence of this virus was definitely established in the experimental greenhouse at Cheshunt. The virus, and the disease it causes, has been fully described by the authors referred to above. The virus is peculiar in being found naturally only in the roots and the lowest leaves of tobacco and other plants. Affected plants shew no signs of disease except necrotic markings on the lowest leaves, and make

normal growth, but when an inoculum prepared from the roots of an infected plant is rubbed on to healthy leaves of tobacco or French bean (*Phaseolus*), necrotic lesions, in which the virus remains localised, result. The disease appears to be of little economic importance, but it has been observed in Australia and its presence at Cheshunt is an interesting record.

10. Fungicides.

W. H. READ.

(a) Sprays.

The fungicidal and phytocidal properties of a number of chemical preparations have been examined. This has been accomplished by comparing the result of spraying a number of tomato plants badly attacked with tomato leaf mould (*Cladosporium fulvum*) with that obtained by spraying similar plants with a standard mixture which has proved effective and is now employed extensively for the control of this disease.

The substances were tried at several different concentrations with agram 2 as a spreader, and also in conjunction with a petroleum emulsion, to test their compatibility with oil emulsions in combined insecticide-fungicide sprays. In most cases comparison was made after the plants had been sprayed three times at ten day intervals. In addition to trials with tomato leaf mould several of the substances were used in tests against cucumber mildew (*Erysiphe cichoracearum*) and rose mildew (*Sphaerotheca pannosa*).

Two samples of red cuprous oxide were tested. Neither of these gave satisfactory control of tomato leaf mould when used at concentrations up to 0.25% with 0.07% of agram 2 as the wetting agent. More promising results were obtained when these cuprous oxides were added to a standard oil emulsion spray in the proportion of $\frac{1}{4}$ oz. oxide per gallon of diluted emulsion. The reason for the increased fungicidal action of many substances when used in combination with oil emulsions is not fully understood, although it may be partly due to the fungicidal action of the petroleum oil. It may also be partly due in some cases to chemical interaction between the emulsifying and stabilising agents in the emulsion, but in many cases increased fungicidal action is obtained where there can be no possibility of chemical action. Promising results were also obtained with a complex ammonium silicate containing copper and zinc, and again the best results were obtained where this was used in combination with an oil emulsion. Recently a sample of cuprous oxide of extremely

fine particle size has been obtained, and this will be tested in large scale trials on tomatoes together with the cuprous oxides previously mentioned and the copper-zinc silicate.

The cuprous oxides did not give as good control of rose mildew or cucumber mildew as the Bouisol-petroleum oil mixture recommended in previous Reports.

Several proprietary fungicidal preparations, a number of which contained copper compounds, have been tested. A colloidal copper hydroxide and petroleum oil mixture has given good results in the control of tomato leaf mould and rose mildew; large scale trials will be conducted with this product during the coming season.

(b) Soil and Seed Treatments.

Additional experiments with cuprous oxide and zinc oxide as dressings for tomato seeds to prevent "damping off" of tomato seedlings due to *Phytophthora cryptogea* have confirmed previous results.

Tomato seeds were thoroughly shaken up with cuprous oxide and zinc oxide powders, and after separation from the excess of fungicide the seeds were sown in soil infected with the fungus *Phytophthora cryptogea*. This treatment did not render the seedlings immune from attack, because severe "damping off" occurred.

Red copper oxide (cuprous oxide) has been shewn by other workers to be of value in preventing pre-emergence damping off due to fungus attack, but under normal conditions loss of tomato seedlings from damping off occurs when a root has developed and the seed treatment fails to safeguard this root.

Several proprietary seed dressings have been tested and found of no value in preventing loss of seedlings from "damping off" due to *Phytophthora cryptogea*.

The importance of using sterilised soil for the propagation of plants from seed cannot be overstressed, particularly as serious losses have occurred on nurseries where unsterilised soil has been used.

Many samples of formaldehyde have been submitted by members for analysis and in most cases these have conformed to the requirements of the Specifications for Certain Insecticides and Fungicides (Bulletin No. 82 of the Ministry of Agriculture).

3. Animal Pests.

1. Rose Thrips.

O. B. ORCHARD, W. H. READ, AND E. R. SPEYER.

The Annual Report of this Station for 1936 contained an account of preliminary experiments on the control of Rose Thrips (*Thrips fuscipennis*). The experiments have been continued throughout 1937 in the rose house and the small experimental house at the Research Station as well as on commercial nurseries.

It has been stated by many workers that Thrips hibernate in the soil and, therefore, preparations were made to test various substances which act as soil insecticides. Before proceeding with this, however, a number of samples of soil from different depths and parts of a house were taken in a nursery where Thrips had been very numerous throughout the previous season. These samples were examined by means of a special apparatus at the Rothamsted Research Station through the courtesy of the Director. A large number of insects were found in the soil but they did not include any hibernating Thrips or other insects injurious to roses and in consequence the use of soil insecticides was not investigated.

At this stage of the investigation Thrips had not been found hibernating in the structure of the houses during the winter, but in view of the negative results obtained from the examination of the soil, it was considered advisable to work on the assumption that the insect hibernated throughout the dormant period either in the superstructure or amongst the bark of the bushes. The following experiments were therefore conducted:—

The effects of various treatments during the dormant period were tested early in 1937 on a commercial nursery in a block of houses in which Thrips had caused serious damage to roses in the preceding year. In one experiment the roses, and also the superstructure and soil surface, were thoroughly sprayed with a well-known proprietary tar-oil water wash at a dilution of 1 in 40 after pruning the bushes early in January. A power sprayer working at 200 pounds per square inch was employed and the bushes were thoroughly drenched.

The second block of houses was fumigated with hydrogen cyanide by scattering calcium cyanide ("cyanogas") on the paths at the rate of 1 ounce to every 1,000 cubic feet, immediately the rose bushes had been pruned. The third block of houses was sprayed and fumigated to combine the two treatments.

Within a week of the appearance of the young shoots adult rose Thrips were found breeding at the bases of the leaf petioles and the first crop of blooms were very seriously damaged by the pest. This damage was equally serious in all three blocks of houses shewing that none of the treatments were effective in destroying the Thrips.

These observations suggested that if the rose Thrips hibernates in glasshouse during the winter in crevices in the bark of the bushes or in the superstructure, these hibernating quarters are so situated that neither fumigant nor insecticide is able to reach them.

Mention was made in the last Annual Report of promising results which had been obtained with a nicotine-oil emulsion spray. As soon as it became obvious that the winter control measures were ineffective routine spraying with this insecticide was commenced, but possibly owing to the soft nature of the growth at this time of year weekly applications, which proved necessary last year, caused slight hardening and pronounced yellowing of the foliage. After six weekly applications of the insecticide had been made it was necessary to discontinue the spraying and abandon the most promising insecticide tested so far.

Many other substances were tried as contact insecticides or as deterrents. Contact insecticides were tried on Thrips-infested pot roses in small chambers by spraying at five day intervals until either it was obvious that the Thrips were not being destroyed or the plants were injured. Several bushes were employed in each test to provide continuity of flowering.

Many of the insecticides were known to kill Thrips when the insects were wetted by the spray, but the results of the tests illustrated the difficulty of controlling the insect when during the greater part of the time it is concealed within the rose buds out of reach of the spraying material. Substances which gave promising results in these tests were tested further in the rose house at the Research Station.

Nicotine and nicotine oleate both appeared to give some control in small scale tests when used at a nicotine content of 1 in 1,000, either with a proprietary wetting agent of known efficiency or in combination with a petroleum oil emulsion. Large scale trials proved very disappointing for injury to blooms continued after five applications of these sprays at five day intervals. The sprays containing petroleum oil emulsion caused injury to the plants when applied so frequently and the colour of the blooms was affected by the nicotine and nicotine oleate sprays containing wetting agents. These trials were conducted during bright weather when repeated damping

down of the roses was necessary, and this may have affected their efficiency. Repeated applications of derris extract (equivalent to 4 ounces rotenone to 100 gallons), pyrethrum extract, quassia extract, and extract of aloes gave no control.

Dusts containing sulphur, ground derris, pyrethrum, and nicotine were also valueless. A number of substances have been tried as deterrents, including emulsified cresylic acid, camphor emulsion, a strongly smelling fraction obtained from beechwood tar, and ortho- and para-dichlorobenzene emulsions. Owing to a disappearance of Thrips from the house it was difficult to assess the value of these, but none appeared promising. Further tests will be made with these and other likely substances. Tests were made with lauryl rhodanate and another complex thiocyanates somewhat late in the season, but the results obtained were rendered valueless by the absence of Thrips on the control plants, and these products will be further examined since it was shewn in laboratory tests that they were highly toxic to Thrips.

Experiments upon the use of poison-baits during the summer months have shewn that a concentration of sodium fluoride or sodium silico-fluoride 1 part to 400 parts sugar solution (5%) is sufficient to kill Rose Thrips provided the insects imbibe the liquid when sprayed upon the foliage. They appear, however, only to do so during or shortly after periods of high temperature and sunlight. It is concluded, therefore, that little hope can be entertained of controlling the insect by such means.

Further efforts were made during the winter of 1937-38 to find the hibernating places of the insect, and as the result of improved technique there is now ample evidence that Rose Thrips remain within glasshouses during the period when the plants are dormant.

Adult females have been found overwintering in crevices in the bark of rose bushes grown under glass, both at the Experimental Station and upon a commercial nursery. Also twelve specimens were collected from a hollow piece of wood lying upon the ground, and one specimen from a dry piece of wood removed from a gutter-board. Further examination of soil, refuse, and moss from beneath plants severely infected during the previous season failed to yield a single specimen, although larvae and adults of Onion Thrips were found in moss. It is, therefore, concluded that Rose Thrips hibernates upon plants and in crevices in the structure of the glasshouse, but not in the soil.

Out-of-doors, the insect has been similarly recovered from the bark of trees, such as chestnut and beech, in company with *Thrips major* Uzel, both sometimes occurring in great numbers, but the latter outnumbering the former by about seven to one.

When pieces of moist bark were placed in glass-stoppered bottles and kept there for a few days, the insects collected upon the inside surface of the stoppers. At first it was surmised that they required much moisture to support life, but it was found later that they could survive in very dry situations, and a saturated atmosphere in a small receptacle is fatal to them within at most a few hours.

Pieces of bark were sprayed with cresylic acid and soft soap 1 : 50, high-boiling cresylic acid and soft soap 1 : 50, formaldehyde 1 : 40, chlornaphthalene emulsion 1 : 100, lime-sulphur 1 : 20, a fruit-tree winter-wash 1 : 14, and an orthodichlorbenzene emulsion 1 : 100. The pieces of bark, each containing about thirty living Thrips were kept in non-airtight glass vessels for a period of three to seven days. Only in the case of the orthodichlorbenzene emulsion were all, or very nearly all, the insects killed after a period of three days.

Fumigation of a small glasshouse with naphthalene or hydrocyanic acid gas failed to kill any appreciable number of the insects in crevices.

Examination of practically the whole of a rose pot-plant, the flowers of which were severely infested in mid-summer, shewed eggs to be present principally in the sepals or flower-stalk immediately adjoining them. None were found in any but the youngest leaf or flower-shoots.

Under favourable conditions of temperature the insect begins to breed in rose houses at the beginning of February, but the main exodus from winter-quarters appears to take place at the end of that month. Experiments in control at this important period are now in progress, and consist of spraying with 2 lbs. derris or pyrethrum powder and 10 lbs. potash soft-soap to 100 gallons water at four day intervals.

2. Onion Thrips (*Thrips tabaci*, Lind.).

E. R. SPEYER.

Further investigations into the egg-laying habits of this insect have been carried out. Unopened flower-buds of carnation of the varieties Topsy and Eileen Low were enclosed together in a flask and numbers of the adult insects introduced. The insects laid their eggs indiscriminately upon the calyces

of both varieties. The apparent immunity from attack exhibited by pink varieties of carnation may therefore be due to a dislike which the larvæ and adults have of feeding upon the petals after the flowers have opened.

Examination of flower buds, at different stages of development, of several varieties highly susceptible to injury, shewed that eggs may be deposited upon the outside of the calyx when the buds are extremely young. In such cases the larvæ, on hatching, may perish in large numbers unless the petals of opening flowers are available as a source of nourishment.

Upon cyclamen the Onion Thrips was found to deposit eggs upon both the upper and underside of young leaves, upon which the larvæ are able to develop. When the flowers began to open, eggs were found only at the bases of the petals upon the *inside*, none being present in the flower-stalks, sepals, or upon the outside of the petals.

3. A Predator upon the Red Spider Mite.

E. R. SPEYER.

Through the kindness of Professor H. S. Smith, of California University, and by means of a permit issued by the Ministry of Agriculture, a consignment of living *Scolothrips sexmaculatus*, Perg., was received from California in October.

The insects were transferred immediately to carnation plants severely infested with Red Spider Mite, but as yet no sign of their increase has been observed.

4. Insecticides.

W. H. READ.

Petroleum oil emulsion sprays remain the standard insecticide for the control of Red Spider Mites on tomatoes, cucumbers, and roses. The repeated application of sprays of petroleum oil emulsion to cucumbers has occasionally caused considerable leaf spotting accompanied by a serious hardening of the plants.

Twelve proprietary petroleum oil emulsions sold for use on tomatoes and cucumbers under glass were tried on a nursery where cucumber plants appeared particularly susceptible to oil emulsion spray injury. Of these only four gave good control of Red Spider Mites without causing visible injury after two applications. The remainder either failed to kill the mites at a reasonable dilution (1% oil in the spray fluid) or caused injury to the plants when used at a concentration which controlled the pest.

Unfortunately none of the emulsions could be applied sufficiently frequently to keep the pest under control without injuring the plants on this particular nursery. The cause of this injury is obscure for the physical properties of the oils used in the four least injurious emulsions were in accordance with the accepted specification for oils suitable for application to the foliage of glasshouse plants, and their degree of refinement as shewn by determining the "unsulphonated residue" was greater than has been considered necessary.

Preliminary experiments have been made in the use of organic thiocyanates for the control of Red Spider Mites. Two have been tested, but so far have caused injury to tomatoes, cucumbers, and roses when applied at concentrations which will kill the mites. Carnations appear more tolerant of these substances, for good results in the control of Red Spider Mites were obtained by spraying these plants with washes containing 0.17% of dodecyl thiocyanate and 0.2% of a product stated to be B. butoxy 6' thiocyanodiethylether.

At these concentrations tomatoes, cucumbers, and roses are injured. Additional tests with these substances will be made on carnations when the growth is soft, since many sprays which can be applied with safety in the absence of soft young growth, cause injury when it is present. Attempts to use these substances as fumigants were disappointing as injury was caused when the substances were volatalised by heat in amounts which did not kill Red Spider Mites.

Methods for the control of several other pests of glasshouse plants have been investigated.

Experiments with the scale insects, *Pinnaspis aspidistræ* (Aspidistra scale) and *Saissetia coffeæ* (Hemispherical scale), attacking ferns, shewed that dipping the plants in or thoroughly spraying them with a petroleum oil emulsion of the type used for spraying glasshouse plants against Red Spider gave very good control of both these insects when the oil content of the wash was 0.8%. No injury to *Nephrolepis bostoniensis*, *Asplenium bubliforum*, or *Pteris major* resulted from this treatment. Satisfactory control could not be obtained by fumigating with calcium cyanide since damage to the ferns resulted at concentrations which were not sufficient to kill the scales.

Experiments were made with the vine weevil (*Ottiorhynchus sulcatus*) attacking Cyclamen corms, but no satisfactory soil insecticide has been found.

Experiments in collaboration with Mr. Orchard were begun on the control of *Tyroglyphus longior* in mushroom beds,

Several dusts containing pyrethrum, derris, and nicotine were tried and found unsatisfactory. Experiments have been commenced with a proprietary saline hypochlorite solution, but this does not appear promising. The only successful treatment has been fumigation with naphthalene. The use of 4 ozs. of grade 16 pure naphthalene scattered on the beds in a commercial mushroom house, effectively controlled *Tyroglyphus* in spawned uncased beds without detriment to the development of the mycelium.

When the beds are cropping, naphthalene should not be employed as injury to young mushrooms occurs and mature mushrooms are tainted. When the mite is present under these conditions the house can be fumigated between flushes by scattering the naphthalene on the paths at the rate of 4 ozs. to 1,000 cubic feet.

4. Chemical Problems.

O. OWEN.

1. General.

The number and range of materials submitted for examination continue to increase, and the areas from which samples are sent also appears to be extending. The majority of samples examined have consisted of soil or water, together with a smaller number of fertilisers and plunging materials. A noteworthy feature is the number of soils which have been examined for their suitability for casing mushroom beds. Of the fertilisers examined none have been found to contain any deleterious material.

For the first time a request was made for an analysis of the air in a mushroom shed. The results, which may be of interest, are shewn in the following table:—

Composition of air in a mushroom shed.

	% Carbon Dioxide.	% Oxygen.	% Nitrogen (by difference).
Ground Level	·302	21·35	78·35
6 feet up... ..	·202	21·89	77·91
11 feet up	·265	21·17	78·57

It was feared that the use of a particular stove would increase the carbon dioxide content of the air in the shed to an amount injurious to the mushrooms. The values shewn are not unlike those obtained on a number of occasions in a shed yielding very good crops and in which no stove was used, all heat being supplied by pipes in the ordinary way.

Of waters examined usually the point at issue was general unsuitability on the grounds of salt content or hardness.

Reports have been made on several samples of waste material offered to growers as being suitable for use as fertilisers. As in previous years the manurial value of some of them proved to be so low that it was insufficient to cover the cost of their transport. In any case it is worth while reminding growers that with such material an important factor is the constancy of composition and unless the supplier can give a real guarantee regarding this, such apparent "bargains" must be suspect.

2. Chlorate Weed-killers.

Inquiries continue to be received concerning plants of various kinds which have suffered damage following the use of weed-killers in which the active principle is chlorate. One case is worth particular mention on account of its interest to chrysanthemum growers. The "standing-out" ground had been treated with weed-killer in the spring of 1936, where it effectively disposed of the weeds and apparently most of the grass. Four thousand chrysanthemum plants stood out later in the year were seriously affected. The best were picked out and removed into the houses but never recovered sufficiently to be of any use. By the late spring of 1937 grass was again growing on the standing-out ground. This was cut and no further weed-killer applied. For the second time the chrysanthemum crop was practically a complete failure. Sufficient chlorate had been taken up by the pots to prove extremely injurious to the plants. Unfortunately it is not easy to remove chlorate completely from pots, but thorough and repeated washing will reduce the amount sufficiently to make it possible to grow chrysanthemums in them.

3. Loss of Nitrogen from Tomato Soil.

In several earlier reports it has been shewn that considerable amounts of nitrate nitrogen are lost from our tomato soils at various times, but particularly after the early heavy waterings. It was further shewn that all loss is not by way of drainage from the soil. This year it has been possible to devote some time to the elucidation of this problem. As a result it has been found that ammonia is being given off from the soil, at all exents from some of the plots. It appears that during the autumn in the plots so far examined the amount may be quite small but the actual amount of ammonia lost in this way has not been accurately determined, nor is there any information as to any possible variation in the amount at various times of the season. Further work is in progress and it is hoped to obtain detailed and accurate results during the coming year.

4. Effect of Manurial Treatment on the Composition of Lettuce.

The interesting effects of variation in manurial treatment on the composition of tomato foliage suggested that similar work on the composition of lettuce grown in our standard plots would prove fruitful. Accordingly analses were made of Cheshunt Early Giant lettuce growing in a soil receiving complete artificials and in soils from which nitrogen,

phosphates, and potash respectively were withheld. A dozen plants were selected at random on the same day from each plot when the plants generally were ready for marketing. The results are as follows :—

Average weight per plant.

	Complete Artificials.	No Nitrogen.	No Phosphates.	No Potash.
As picked	138	123	123	68·6
Relative	100	89	89	50
Oven dried	5·63	4·60	3·90	3·10
Relative	100	82	69	55

As was to be expected omission of any nutrient depresses the green and dry weights. Noteworthy is the very low value for plants grown in the plot from which potash is omitted, the weight being only half that of plants grown with complete artificials. The figure draws attention to the importance of potash as fertiliser for winter lettuce grown under glass.

Percentage composition of dried matter.

Treatment.	Ash %.	Nitrogen %.	Phosphoric Acid P_2O_5 %.	Potash K_2O %.
Complete Artificials	24·36	5·886	2·151	11·72
Phosphates and Potash only ...	29·19	4·969	2·105	13·97
Nitrogen and Potash only ...	32·45	4·751	1·601	14·23
Nitrogen and Phosphates only	21·50	5·985	1·840	4·234

As will be seen from these figures there is no clear cut relationship between the omission of phosphate and potash on the one hand and potash and phosphoric acid contents respectively on the other hand as there was in the case of tomato foliage. Here the omission of nitrogen hardly affected the percentage of phosphoric acid and increased the percentage of potash. Omission of phosphate depressed nitrogen but increased the potash percentage. Omission of potash depressed phosphoric acid and brought the potash to an extremely low value.

Total amounts per plant (gms.).

	Nitrogen.	Phosphoric Acid P_2O_5 .	Potash K_2O .
Complete Artificials	·2400	·1211	·6600
Phosphates and Potash only ...	·2284	·09674	·6421
Nitrogen and Potash only ...	·1856	·06246	·5555
Nitrogen and Phosphates only ...	·1858	·05710	·1314

In general it will be seen that compared with those growing in soil treated with complete artificials the plants in soil from which any one nutrient is withheld take up less of all nutrients although in some cases the differences are small. It is curious that plants receiving no nitrogen take up more nitrogen than those which receive no phosphates and no potash respectively.

5. Miscellaneous.

1. Experiments on Irradiation.

W. F. BEWLEY, W. H. READ AND O. B. ORCHARD.

The experiments on the use of electric light in the propagation of cucumbers, which began several years ago, were continued in 1937, when most of the cucumber plants received artificial light during propagation. The results of previous years shewed that if seeds were sown after the middle of December the plants which received five hours additional light of 280 foot candles intensity in extension of the daylight period commenced to fruit about ten days earlier than plants grown without artificial light. The total weight of fruit during the whole life of the plants was slightly greater from the controls than from the irradiated plants (*i.e.*, the plants which received artificial light). Thus the only profit derived from the use of artificial illumination comes from the higher prices obtainable for the earliest produce. If as good a crop can be obtained equally early without the use of artificial light by sowing seeds even earlier, the only advantage of plant irradiation must be the saving in fuel consumption due to the shorter propagating period resulting from the more rapid growth of the treated plants.

Since the prices obtainable for cucumbers falls rapidly and after about the middle of February fluctuates round a mean value it is necessary to produce fruit before then if advantage is to be obtained from the high prices. The cucumber plants for the 1937 crop were therefore propagated from seeds sown on 5th November, 1936. One third of the plants were given five hours' illumination of 280 foot candle intensity before dawn by suspending 500 watt gas-filled lamps about 3 feet above the plants, one third received light of 70 foot candle intensity for the same period whilst the remainder were grown without artificial light. Seeds were sown in "60" pots and as the rate of growth demanded the plants were potted into "32" pots as follows:—Those receiving light of 280 foot candle intensity on 8th December, those receiving 70 foot candles on 12th December, and the untreated plants on 29th December.

The 280 foot candle and 70 foot candle series made sufficient growth to be planted out in beds on 30th December and the untreated plants on 11th January.

After planting out, the plants raised with artificial light retained their advantage in size compared with the control plants, but the lower lateral shoots did not develop as

satisfactorily as those on the control plants. In an attempt to induce the production of laterals the plants of all groups were stopped when they reached the eighth supporting wire—that is when they were 6 feet high in the main stem. The results suggest that this treatment was probably too late to greatly effect the lowest lateral shoots of the plants propagated under electric light but hastened the growth of those higher up the stem. The lower laterals on the control plants developed and produced fruit normally, while the lower laterals on the plants which were propagated under electric lights produced fruit about three weeks after fruit had been obtained from third and fourth laterals.

Table 1 shews the total fruit production to date per plant of the different groups of plants. The size and quality of the fruit from the three groups was the same. The figures given for April and May are compiled from the weekly totals from the three cuttings made each week.

Table 1.

Date				TOTAL FRUIT PICKED PER PLANT		
				280 f.c. Series	70 f.c. Series	Control Series
February	19th	...	...	.36	—	—
"	22nd	...	...	.88	.15	.05
"	24th	...	...	.92	.45	.07
"	26th	...	...	1.24	.89	.12
March	1st	...	...	1.44	.95	.16
"	3rd	...	...	1.64	1.25	.37
"	8th	...	...	2.79	2.25	1.61
"	12th	...	...	3.69	3.10	2.54
"	15th	...	...	4.43	3.88	3.12
"	17th	...	...	4.77	4.32	3.45
"	19th	...	...	5.29	4.94	4.23
"	22nd	...	...	5.87	5.66	5.23
"	24th	...	...	6.61	6.23	6.53
"	26th	...	...	7.33	6.86	6.93
"	31st	...	...	9.01	6.98	7.57
April	7th	...	...	11.96	10.48	10.52
"	14th	...	...	14.33	12.68	13.22
"	21st	...	...	15.89	14.38	15.32
"	28th	...	...	20.24	17.83	19.02
May	5th	...	...	22.84	20.83	22.72
"	12th	...	...	25.34	23.03	25.32
"	19th	...	...	28.34	26.08	27.62
"	26th	...	...	31.04	29.08	30.12

Reference to the Table shews that the plants which received light of 280 foot candle intensity commenced to fruit earlier than the control plants and produced one fruit per

plant by 25th February whilst the control series did not yield one fruit per plant until 6th March. After the third week in March the greater number of fruits obtained from the control plants frequently brought the total yield of both series to the same level. Since other experiments necessitated removing some of the crop on 9th June it is impossible to say what the total crop would have been if all the plants were retained until the end of the season. There is no reason to expect that the final results would have differed from those of previous years when the total weight was approximately the same irrespective of the treatment received by the plants during propagation. Consequently the gain resulting from the use of electric light of 280 foot candle intensity during propagation can be assessed as the difference in selling price obtained by producing one cucumber per plant at the end of February instead of, say, the last week in March less the cost of heating the plants for twelve days when planted out: the period of twelve days being the difference between the times of planting. The price of cucumbers was approximately 8·8d. each during the last week in February and 5·4d. each during the last week in March, so that an estimated increased return of £51 per acre resulted at the usual planting rate of 3,600 plants per acre. Twelve days fuel for an acre of cucumbers costs approximately £16 and the cost of electricity plus the amortisation charges on the electrical equipment will be approximately £40 per acre with electricity at $\frac{1}{2}$ d. per unit.

The irradiation of cucumbers with electric light of 280 foot candle intensity with current at $\frac{1}{2}$ d. per unit is therefore uneconomic under the conditions of these experiments.

By using light of 70 foot candle intensity the plants produced one cucumber per plant by 2nd March. The price of cucumbers was approximately 7·7d. each during the first week in March or 2·3d. more than at the time the control plants produced a fruit per plant. This corresponds to £34 10s. per acre of 3,600 plants, and the cost of fuel, electricity, and amortisation charges is estimated to be £25 with electricity at $\frac{1}{2}$ d. per unit.

Assuming the crop at the end of the season would have been the same irrespective of the method of propagation a slight gain resulted from irradiating the plants at 70 foot candle intensity, but such a slight gain is negligible.

Furthermore it is probable that equally early cucumbers could have been obtained without the use of electric light by sowing seeds about a fortnight earlier, and so it must be concluded that the use of electric light for cucumber propagation is at present unprofitable. It is not intended to continue these experiments.

2. Further Observations on factors affecting the position of the first inflorescence in the tomato.

D. W. GOODALL.

(a) Light.

In the Annual Report for 1936, experiments were described shewing that in summer a shortened day caused tomato plants, variety E.S.1., to flower at a rather less advanced stage of development. It is now possible considerably to amplify these results.

The experiments of 1936 were conducted with the day reduced to seven hours. This appears to be the minimum length that has any favourable effect in the ordinary mid-summer conditions. When a day of six hours was used (see Fig. 1), flowering took place after rather more leaves had been formed than under the normal day, whereas a day reduced to twelve hours advanced flowering as much as did one of seven hours.

These statements however are true only of plants grown during the summer. In the autumn, shortening of the day no longer favours flower formation. In Table 1 are given the results of two experiments in which some plants were subjected to a shortened day of seven hours, while others were artificially illuminated during the night, with an intensity of 150 foot candles.

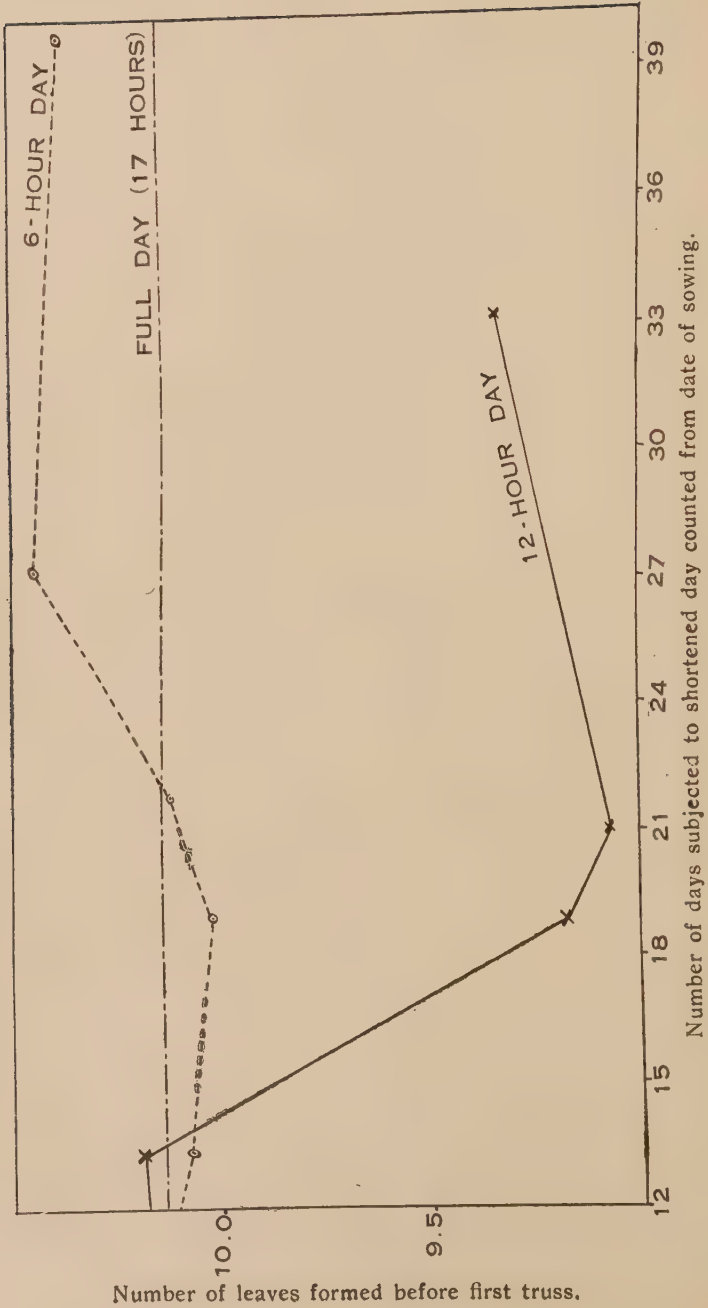
Table 1.

Effect of day length on number of leaves below the first truss.

Length of day	Number of leaves before the first truss			
	Sown 18/9/36		Sown 2/10/36	
	Mean	Standard Error	Mean	Standard Error
7 hours	12.48	0.13	—	—
Normal day ...	11.48	0.09	13.08	0.32
24 hours	11.37	0.20	11.30	0.23

The prolonged day had no effect on the batch sown in September, but in the second batch it caused fewer leaves to be formed before the first truss.

Figure 1.



It was thought that the unfavourable effect of a shortened day in autumn might be due not to the length of day but to the reduction in the total amount of light that the plant received. Accordingly, an experiment was carried out in September, 1937, in which batches of plants were subjected to different lengths of day, but those receiving a larger number of hours of daylight were kept under shades of such density that the total light falling on each batch was the same.

The results in Table 2 shew that the change in flower position under a shortened day was not due to a reduction in the total light falling on the plant.

Table 2.

Day Length	% Shading	Number of leaves before inflorescence	
		Mean	Standard Error
6 hours 	None	12.26	.12
7 hours 	12.5	13.85	.16
8 hours 	14.5	12.71	.18
9 hours 	18.1	13.00	.20
Full Day 	36.0	11.74	.17
Full Day 	None	11.05	.10

The last two lines of Table 2 indicate that the intensity of the light may also play a part in determining the position of the first truss. This was verified in an experiment designed for this purpose. Plants were grown under cloth shades of various thicknesses, the length of day and other conditions being the same for all batches. The results are shewn in Fig. 2.

It seem probable from this diagram that the greater number of leaves below the first truss in plants grown in midwinter may be partly ascribed to low light intensity.

(b) Condition of the seed.

In last year's annual report, it was suggested that the age of the seed affected the stage at which flowering took place. This has been fully confirmed during the past year. In the first place, as the seed became older, the proportion of plants

in which the first two leaves were opposite increased from few, when the seed was fresh, to some 50% when the seed was two years' old. Since these plants form more leaves under the inflorescence than the more usual type in which the first two leaves are alternate, the increase in their numbers would necessarily lead to a progressive increase in the mean number of such lower leaves. It is, however, found that within each of these two types the mean number of leaves before the inflorescence increases with the age of the seed. In Table 3 are the figures for alternate-leaved plants only.

Figure 2.

Position of truss in plants grown under cloth shades.

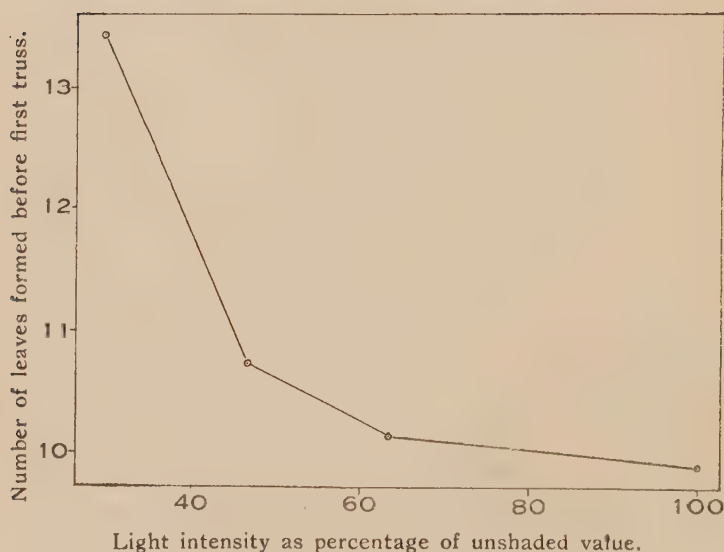
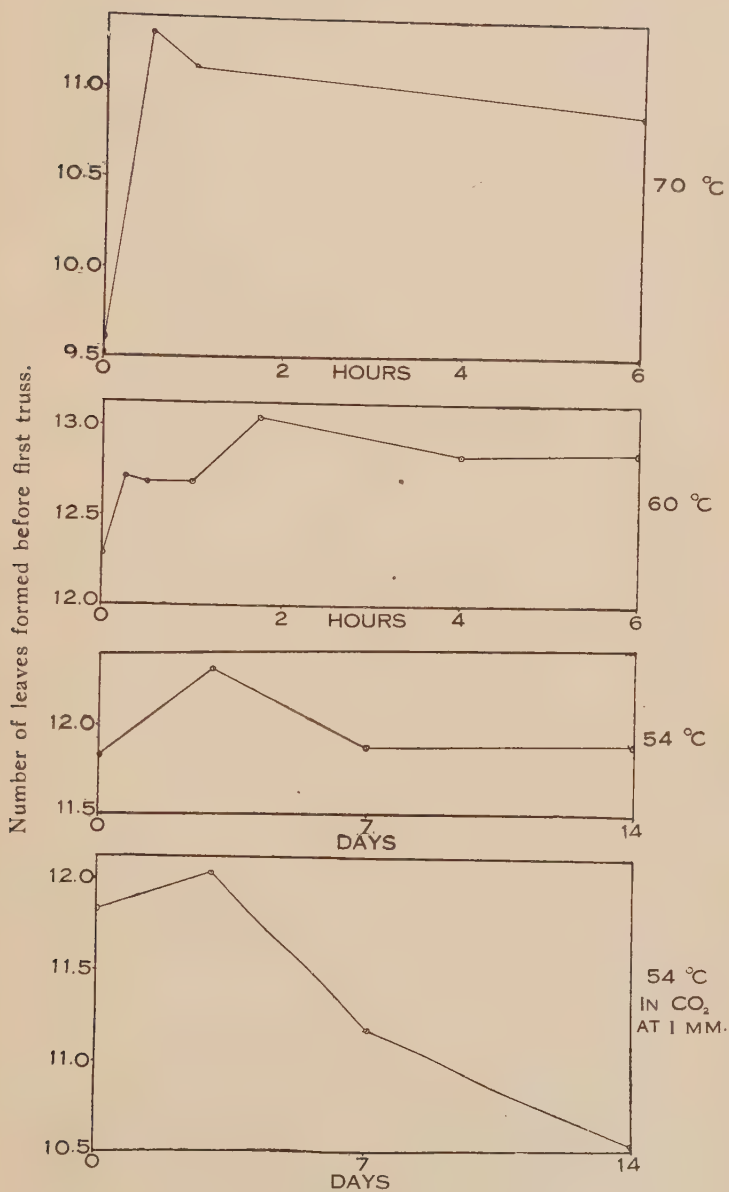


Table 3.

Age of seed	Mean number of leaves before the first truss	
	Sown 17/11/36	Sown 12/7/37
Fresh seed	14.43	11.29
One year	14.85	11.55
Two years... ..	14.83	12.31
Three years	14.89	13.17

Figure 3.



Length of time subjected to treatment.

An attempt was made to reproduce this effect of ageing by artificial means, namely, by subjecting the dry seeds to high temperatures for some hours. The effect of high temperature was also tried when the seed was deprived of oxygen. The results are shewn in Fig. 3

Treatment at 60°C. and 70°C. increased the number of leaves before flowering. 54°C. had little effect under aerobic conditions, but with anærobic conditions fewer leaves were produced. When this last treatment was continued for 28 days, the seed no longer germinated. The higher temperatures under aerobic conditions also shewed a reduction in percentage and rate of germination, and there were a number of abnormal seedlings.

3. The Effect of Nitrogen and Potassium starvation on the Fruiting of the Tomato.

H. L. WHITE.

An account of an investigation of the effect of nitrogen and potassium starvation on the fruiting of the tomato was published in the *Annals Applied Biology* XXV. 20-49. Some of the conclusions are summarized below.

(1) Nitrogen starvation reduces the number of blossom-buds formed, the percentage of buds that open and the mean numbers of fruits per flower-truss. Potassium starvation does not affect the number of blossom-buds formed or the percentage of buds that open but reduces the mean number of fruits per flower-truss.

(2) An outstanding feature of nitrogen starvation is retardation of the rate of development of successive flower-trusses. With potassium starvation the rate of development is accelerated. Growth, estimated from increase in height of plants trimmed to a single axis by continuous removal of incipient axillary shoots, is retarded by both nitrogen and potassium starvation.

(3) The "maturation period" (between opening of the blossom and ripening of the fruit) is lengthened by potassium starvation, shortened by moderate nitrogen starvation and lengthened by severe nitrogen starvation. From the present results, in conjunction with data published previously, it is concluded that the "maturation period" is shortened by a high carbohydrate-nitrogen balance and lengthened by a low carbohydrate-nitrogen balance.

(4) In mid-season all plants suffer a check to growth and development demonstrated by (a) retardation of the rate of differentiation of leaves and flower-trusses; (b) cessation or growth in height and (c) the occurrence of a high proportion of fruit with arrested development. This "mid seasonal check" is accentuated by nitrogen and potassium starvation, especially the former, corresponds with the period of maximal weight of developing fruit, and is attributed to competition for nutrient supply between the fruits and vegetative parts of the plants, leading to apparent antagonism between these processes.

(5) The observed effects of potassium deficiency on fruiting (acceleration of development of flower trusses, failure of pollination and prolongation of the "maturation period" of the fruit) are those also associated with carbohydrate deficiency relative to nitrogen supply.

APPENDIX A.

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Manurial Treatment in Tomato Experiments.

(1) Lime.

All houses received ground caustic lime at the rate of 2 tons per acre.

(2) Stable Manure.

Houses 1, 2, 6, 8 to 10, received 15 tons horse manure per acre, except plots 1, 2, 3, 13 and 14, house 4.

(3) Base-dressing.

Houses 1 to 4, 6, 8 to 10 received $\frac{3}{4}$ -lb. per square yard of the following mixture:—

- 1 part bone meal.
- 1 part bone flour.
- 1 part hoof and horn.
- 1 part sulphate of potash.

Houses 5, 7, 11 and 12 received $\frac{1}{4}$ -lb. sulphate of potash per square yard only.

4) Top-dressing.

SULPHATE OF POTASH.—All houses received a first top-dressing of sulphate of potash at the rate of 2-ozs. per square yard

FERTILISER MIXTURE.—All houses except plots 1, 2, 3 and 12, 13 and 14, house 4 received 2-ozs. per square yard of the following mixture every fourteen days at discretion:—

- 3 parts sulphate of ammonia.
- 2 parts dried blood.
- 7 parts 30% superphosphate.
- 5 parts pure dissolved bones.
- $\frac{1}{2}$ part bone flour.
- $2\frac{1}{2}$ parts sulphate of potash.

All houses received three top-dressings of the following mixture at the rate of 2-ozs. per square yard:—

- 1 part sulphate of ammonia.
- 1 part nitrate of potash.
- 3 parts superphosphate.
- 5 parts dried blood.

APPENDIX C.

Manures applied to Plots 1-3, and 12-14 in Tomato House 4.

Plot.	TITLE.	Base Manure in Lbs. per sq. yd.				* Top-dressing in Lbs. per sq. yd.			
		Lime.	Stable Manure.	Basic Slag.	Sulphate of Potash.	Super- phosphate.	Sulph. of Ammonia.	Nitrate of Soda.	Sulph. of Potash.
1	Complete Artificials (I.) without Nitrogen	1.0	—	0.4	0.1	0.5	—	—	0.2
2	Unmanured	1.0	—	—	—	—	—	—	—
3	Complete Artificials	1.0	—	0.4	0.1	0.5	0.2	0.2	0.2
12	Complete Artificials with Dung	1.0	7	0.4	0.1	0.5	0.2	0.2	0.2
13	Complete Artificials without Phosphates	1.0	—	—	0.1	—	0.2	0.2	0.2
14	Complete Artificials without Potash	1.0	—	0.4	—	0.5	0.2	0.2	—

* The Top-dressing was applied in eight equal instalments.

APPENDIX D.

Dates of Cultural Operations 1936—1937.

Crop.	Sown.	Potted into 60's.	Potted into 32's.	Planted out in borders.	First Mulching.	First Top Dressing.	First Fruit Picked.	Last Fruit Picked.
Cucumbers ...	Nov. 5 1936	—	Dec. 2 1936	Jan 1 1937	Feb. 10 1937	Feb. 17 1937	Feb. 19 1937	* July 23 1937
Tomatoes ...	Dec. 16 1936	Jan. 20 1937	—	Mar. 8 1937	—	May 18 1937	May 24 1937	Oct. 18 1937

* End of first crop.

Month.	Air Temperatures					Grass Temp.			Rainfall				Mean Soil Temperatures		Hygrometer				Bright Sunshine		Baro- meter			
	Mean		Absolute		Absolute Min.	Av. Min.	Temp.	Date	Total Precipitation	No. of Days of Fall	Greatest Fall	Soil Temperatures		Dry Bulb	Depress. of Wet Bulb	Relative Humidity %	Dew Point	Total No. of Hrs. age.	Daily					
	Max.	Min.	Max.	Date								1 ft.	2 ft.							°F.		°F.	°F.	°F.
	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.				
January	...	...	46.9	34.9	54.0	6th	26.0	8th	31.9	24.0	8th	3.15	12	0.55	24th	40.1	41.9	43.6	1.5	88.6	38.9	18.9	0.61	29.73
February	...	...	49.6	37.1	63.0	9th	30.0	23rd	34.5	27.0	{ 11th 17th	2.99	16	0.52	24th	40.2	41.7	44.8	1.6	88.4	41.2	54.35	1.94	29.58
March	...	...	47.2	33.6	56.0	20th	25.0	9th	31.0	22.0	9th	2.18	13	0.63	13th	39.6	40.9	44.3	2.7	79.7	36.7	72.50	2.60	29.62
April	...	...	56.6	41.3	62.0	{ 9th 27th	35.0	26th	40.3	31.0	26th	3.13	13	0.80	16th	48.6	47.9	51.2	3.3	71.1	41.3	80.15	2.70	29.84
May	...	...	65.6	46.5	83.0	29th	40.5	17th	44.1	37.0	{ 4th 5th	3.2	11	0.78	20th	55.5	54.3	58.5	5.3	73.1	48.2	157.90	5.10	30.29
June	...	...	70.9	47.9	83.0	{ 5th 8th	40.0	6th	45.4	37.0	20th	2.32	6	0.79	12th	63.9	62.6	64.1	4.5	77.6	56.7	178.00	5.90	30.06
July	...	...	70.9	53.4	85.0	{ 3rd 14th	45.0	7th	49.6	40.0	7th	2.41	11	1.3	15th	65.0	64.7	65.6	5.5	72.4	56.0	129.20	4.20	30.02
August	...	...	75.1	54.2	87.0	6th	46.0	22nd	50.4	42.0	{ 15th 22nd	2.22	6	1.5	13th	64.9	64.8	67.4	4.7	75.9	59.1	179.80	5.80	33.30
September	...	...	68.0	45.0	88.0	10th	35.0	20th	41.2	32.0	20th	1.57	9	0.52	17th	59.6	58.8	59.4	4.1	76.3	51.6	136.70	4.60	29.97
October	...	...	59.7	44.7	69.0	2nd	34.0	15th	40.1	30.0	15th	2.16	10	0.95	21st	52.1	52.9	54.9	2.6	88.8	49.8	62.30	2.00	30.00
November	...	...	48.4	40.8	55.0	2nd	23.0	25th	31.9	19.5	12th	1.46	7	0.84	1st	43.1	46.4	44.4	1.6	88.2	41.0	49.50	1.60	30.05
December	...	...	41.8	32.4	55.0	23rd	23.0	25th	28.1	18.0	{ 18th 19th 20th	3.43	11	0.82	14th	39.5	41.3	38.2	1.5	88.1	35.1	16.40	0.50	29.75

Total rain for year, 30.22 ins.

No. of days precipitation, 125.

Total bright sunshine for year, 1135.2 hours.

DIAGRAM SHEWING ARRANGEMENT OF EXPERIMENTAL PLOTS, 1937.

